Prioritizing Learning

Learning from past projects to improve cost-estimation in the road construction industry

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Learning from past projects to improve cost-estimation in the road construction industry

by

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Preface

Almost eight years ago, I began my academic journey at Avans University of Applied Sciences in 's-Hertogenbosch, enrolling in the Civil Engineering program. Now, as the end of my student life approaches, so does the completion of this master's thesis.

After completing my HBO bachelor, I realized that my interests lie not only in the technical aspects of engineering but also in project management. This insight led me to pursue the Master's in Construction Management and Engineering at TU Delft. However, the transition was far from easy. The pre-master phase proved particularly challenging, with more math retakes than I can remember. Still, it was a period that tested my perseverance and resilience. Looking back, despite the setbacks, I would choose this path again without hesitation. It has been a transformative experience, one that pushed me to my academic limits and contributed profoundly to my personal and professional development. During a gap in my studies, I gained new perspectives while working at a contractor that further refined my professional interests—specifically, in the critical gap between tender and execution phases in infrastructure projects. This realization reinforced my decision to focus on project and infrastructure management. My thesis topic sits at the heart of this intersection and is of increasing importance as infrastructure projects grow in complexity and demand more learning and collaboration.

I would like to express my sincere gratitude to my supervisors, Alfons van Marrewijk, Johan Ninan, and Kirsten van Zalinge, for their invaluable guidance over the past months. Alfons, thank you for continuously steering my thesis toward greater academic rigor and for challenging me to think more critically. Johan, I am grateful for your sharp insights and consistent feedback. The weekly group sessions were a source of both structure and inspiration. Kirsten, thank you for responding to my message on LinkedIn and trusting me with this opportunity. Your guidance during our weekly meetings, as well as your encouragement and genuine concern for my personal interests, meant a great deal, whether it was helping with the topic or going through the "Bouw CAO" to ensure that I was reimbursed for my travel expenses.

I also want to thank the broader graduation company team for making me feel welcome and involved. Working within the team provided valuable insight into real-world cost estimation and the dynamics of team-based decision-making. I am especially thankful to all the interviewees who took the time to share their insights and experiences. Your openness was essential to the success of this research.

To my family, thank you for your unwavering support throughout this long journey. I am especially grateful to my parents, who always supported me and created an environment in which I could fully focus on my studies, especially during intense internships marked by constant sleep deprivation. My sister, Dr. A. Limburg, for checking the academic structure. To my girlfriend, Ana, thank you for your constant support both emotionally and as a personal math tutor during the tough days of the pre-master. Every 5.8 would have been much lower without you. Jari, thank you for lending me your car from time to time in these last months and for helping me navigate key moments in this thesis. And thanks to my friends both inside and outside the TU Delft for making this journey more enjoyable and manageable.

Finally, I wish you, the reader, a pleasant read. I hope you find this thesis as engaging as I found it interesting to write. I also hope that this research contributes in some way to a more robust cost estimation process, supporting smarter, more efficient infrastructure development and ultimately contributing to a more beautiful and well-built Netherlands.

Pelle Limburg
Delft, July 2025

Executive Summary

This thesis addresses the persistent challenge of cost estimation inaccuracies in the Dutch road construction industry, with particular emphasis on learning from previous projects to improve forecasting practices. Despite substantial progress in estimation techniques, cost overruns continue to undermine budget reliability and efficiency, frequently resulting in project delays and financial inefficiencies. To better understand and address this persistent issue, this research explores the following question: *How can learning from previous projects be strengthened to improve the accuracy of cost estimation during the tendering phase?* The study investigates the underlying causes of these inaccuracies and proposes targeted strategies to enhance organizational learning and subsequently improve the accuracy of cost estimation during the tendering phase.

The research identifies a substantial gap in systematically leveraging past project experiences. Even though practitioners recognize the value of reflecting on past projects, organizational conditions often prevent meaningful learning. Key barriers identified include time constraints, limited formal structures for knowledge capture, and cultural resistance characterized by blame avoidance and siloed information. These factors frequently result in repetitive estimation errors, regarding, for example, staffing costs, where analysis reveals an average deviation of 45% from initial budget estimates.

Methodologically, the study employs a mixed-method approach. A quantitative analysis was conducted on data from 18 recently completed road projects within a major Dutch contractor, highlighting significant deviations in staff cost estimations. Qualitative insights were gathered through 23 semi-structured interviews with professionals at the contractor involved in estimating, executing, and controlling road infrastructure projects. These interviews provided crucial context, uncovering practical and organizational reasons behind the observed deviations.

To explain where and how learning breaks down, the study builds on established theory in organizational learning. It introduces an integrated multi-level learning framework, drawing on Crossan et al.'s (1999) 4I model and its expansions by Jenkin (2013) and Wodnik et al. (2024). In this framework, projects are viewed as temporary organizations embedded within a broader coordinating structure. Learning is conceptualized as a progression through key processes: intuiting, interpreting, integrating, and institutionalizing. Two additional processes are included to reflect recent theoretical developments: interaction and incorporation.

The practical recommendations derived from this study are structured using the Plan–Do–Check–Act (PDCA) cycle, a widely used continuous improvement framework that supports iterative and systematic implementation of change. Key proposals include institutionalizing project evaluations by scheduling them at project initiation, creating structural ”learning slack” by allocating dedicated reflection time, simplifying data systems to enhance usability, and promoting stronger interaction between estimators and execution teams. These initiatives aim to foster an organizational environment where reflective practices become routine rather than exceptional. Emphasizing cross-regional knowledge exchange within the organization and establishing clearer accountability structures for capturing and applying project insights further complements the recommended strategies. In essence, this thesis finds that improving cost estimation accuracy hinges on institutionalizing a culture of structured reflection and learning within the organization.

Ultimately, the study underscores that improving cost estimation accuracy requires more than technical enhancements. Organizational commitment to structured reflection, effective feedback loops, accessible data systems, and cultural incentives for continuous improvement is essential. Prioritizing structured and systematic learning from previous projects offers a robust pathway toward achieving more reliable and accurate cost estimations, contributing significantly to the efficiency and sustainability of infrastructure development.

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Abbreviations & Glossary

Abbreviations

Abbreviation	Dutch Term	English Translation
BPKV	Beste Prijs-Kwaliteitverhouding	Best Price-Quality Ratio
EMVI	Economisch Meest Voordelige Inschrijving	Economically Most Advantageous Tender
GWW	Grond-, Weg- en Waterbouw	Civil Engineering (Earthworks, Roads, and Waterworks)
KAM	Kwaliteit, Arbo en Milieu	Quality, Health, Safety, and Environment
RAW	Rationalisatie en Automatisering Grond-, Water- en Wegenbouw	Standardization and Automation in Civil Engineering
UAV-GC	UAV - Geïntegreerde Contracten	Integrated Contract Conditions (UAV-GC)
UTA	Uitvoerend, Technisch en Administratief personeel	Executive, Technical and Administrative Staff
UAV	Uniforme Administratieve Voorwaarden	Uniform Administrative Conditions

Table 1: List of Abbreviations

Glossary

English Term	Dutch Term
Bid / Tender	Aanbesteding / Inschrijving
Bottom-Up Initiative	Bottom-up initiatief
Branch Office	Vestiging
Business Controller	Bedrijfscontroller
Calculation Department	Calculatieafdeling
Contractor	Aannemer
Cost Code	Kostenpost
Contractsum	Aanneemsom
Cost Estimate	Kostenraming
Cost Estimation	Kostenschatting
Cost-Estimator	Calculator
Cross-Project Learning	Project overstijgend leren
Evaluation	Evaluatie
Execution (construction)	Uitvoering
Execution Team	Uitvoeringsteam
Failure Costs	Faalkosten
Final Tender Pricing Meeting	Schrijfcijferoverleg
Final Tender Offer	Schrijfcijfer
Feedback	Terugkoppeling
General Costs	Algemene kosten
Head of Project Office	Hoofd bedrijfsbureau
Kick-off	Startoverleg
Local Office/Branch	Lokale vestiging
Managing Director	Directeur
Operations Manager	Bedrijfsleider
Post-Calculation	Nacalculatie
Project Manager	Projectleider
Sister Company	Zusterbedrijf
Site Manager	Uitvoerder
Staff	UTA (Uitvoerend, Technisch, Administratief)
Work Preparation	Werkvoorbereiding
Work Preparator	Werkvoorbereider

Table 2: Glossary

1
Introduction

1.1. Problem context

Decades of research show that transport projects—roads, rails, bridges—often cost more than planned (Cantarelli, Molin, et al., 2012; Flyvbjerg et al., 2018; P. E. D. Love et al., 2015; Molinari et al., 2023; Odeck, 2004, 2019). Dutch road projects follow this global trend, regularly exceeding initial budgets (Cantarelli, Flyvbjerg, & Buhl, 2012). Improvements in planning methods have not solved this issue. Recent European studies report overruns in over 80% of projects, averaging 20–30% extra costs (Molinari et al., 2023). These persistent overruns suggest deeper organizational and behavioral problems.

It is essential to define cost overruns precisely to understand their impact and address their prevalence. Within the field of infrastructure management, cost overruns are described as the percentage difference between the actual out-turn costs and the estimated costs at the formal decision point (Cantarelli, Molin, et al., 2012; Nijkamp & Ubbels, 1999). Formally, cost overrun is expressed as:

Cost Overrun (%) = [(Actual Cost − Estimated Cost) / Estimated Cost] × 100

The type of contract impacts cost accuracy. Dutch public-private partnerships (PPP, typically DBFM) have lower cost overruns compared to traditional contracts (RAW-Bestek, UAV-GC). For example, PPP highway projects recently averaged only 6% overruns (Verweij & Van Meerkerk, 2021). Traditional contracts, often rigid, can cause conflicts and high overruns due to inflexible scopes (Sheamar et al., 2024).

A key reason for ongoing overruns is poor learning from past projects. Construction teams often break up after completion, losing valuable knowledge. Reviews conducted post-project rarely improve future projects (Debs & Hubbard, 2023). Repeated mistakes like design errors and poor risk planning keep happening, showing a lack of learning and organizational memory (Durdyev, 2021).

Adding to this issue, the construction sector faces severe skilled workforce shortages. Over two-thirds of Dutch construction firms report workforce shortages, the highest among Dutch industries (Centraal Bureau voor de Statistiek, 2025). According to the Economisch Instituut voor de Bouw (EIB), the construction workforce market is extremely tight, with high vacancy rates leading to delays, especially in infrastructure (GWW) projects. This shortage disrupts learning, as fewer experienced workers mean less effective knowledge transfer, hindering accurate cost estimation and timely project completion (Economisch Instituut voor de Bouw, 2024). Immediate project demands often overshadow long-term improvement efforts, further hindering accurate cost estimation.

1.2. Research gap

Despite decades of research on cost overruns, there remains a clear gap in understanding how organizations actually apply lessons from previous projects to improve cost estimation. While the phenomenon of overruns is well-documented, the use of cost-related knowledge from previous projects in practice is limited.

In particular, the factors that enable or hinder learning across projects—such as time pressure, fragmented teams, or missing feedback loops—have not been systematically examined in relation to cost estimation. Additionally, the attitudes and experiences of cost estimators, who may face pressure to underbid in the tenderphase are rarely explored.

Finally, practical strategies to embed learning into cost estimation remain underdeveloped, especially in the face of staffing constraints. Addressing this gap is crucial for enabling more accurate forecasting and reducing systemic overruns in construction projects.

1.3. Research objectives

The principal aim of this thesis is to investigate how learning from previous projects can enhance the accuracy of cost estimation in Dutch road construction. To achieve this, the following objectives are pursued:

1. **Analyze the current state of learning from previous projects in cost estimation.**
   Examine existing practices in the Dutch road construction sector, identifying gaps between formal lessons-learned processes and their practical implementation.
2. **Identify barriers and enablers affecting learning from previous projects.**
   Determine which factors most strongly influence the effectiveness of learning from previous projects in cost estimation.
3. **Assess awareness and attitudes of cost estimators.**
   Investigate how estimators and managers perceive recurring cost issues and their openness to knowledge-sharing.
4. **Recommend strategies to strengthen learning from previous projects.**
   Propose evidence-based practices to embed continuous learning into organizational routines related to cost estimation.

1.4. Research questions

These objectives translate into the following research questions:

Research questions

1. What is the current body of knowledge on learning from previous projects and cost estimation in the construction industry?
2. What is the employee perception on learning from previous projects with the goal of improving the accuracy of cost estimation?
3. Which barriers hinder the application of learning from previous projects to improve the accuracy of cost estimation in Dutch road construction?
4. What are strategies to improve learning from previous projects for cost estimation in the context of Dutch road construction?

Main research question

> ***"How can learning from previous projects be strengthened to improve cost estimation accuracy of Dutch road construction projects?"***

These questions guide the data collection, analysis, and formulation of practical recommendations.

1.5. Research Scope

This thesis is situated within the debate on cross-project learning in project-based organizations, specifically in the context of cost estimation accuracy in Dutch road construction. While organizational learning provides the broader conceptual foundation, the study narrows in on how knowledge from past projects can be effectively transferred and institutionalized to improve estimating practices. In doing so, it examines the barriers, routines, and actor roles that shape learning continuity across temporary project boundaries.

1. Sectoral Emphasis and Location
The research exclusively addresses road construction projects from a contractor's point of view in the Netherlands. Other forms of infrastructure, such as rail or waterway development, do not fall within its scope.

2. Project Size
The research focuses primarily on small to mid-sized road construction projects (projects with an estimated cost of a maximum of 10 million euros). This emphasis addresses a gap in existing research, which typically prioritizes large-scale, high-profile infrastructure projects. Smaller projects, despite comprising a substantial proportion of the industry workload, have received relatively limited attention regarding learning from previous projects' practices and cost estimation accuracy.

3. Cost Estimation Processes
The investigation targets the phase of project development where cost estimations play a pivotal role in decision-making and budget allocation. As a result, additional financial practices such as post-construction auditing or life-cycle costing receive only brief mention. The research prioritizes the methods and tools used to generate initial cost forecasts instead.

4. Learning from Previous Projects as a Subset of Organizational Learning
While knowledge management spans a broad spectrum of organizational theories and practices, the thesis focuses on learning from previous projects. This encompasses the mechanisms through which insights and best practices are transferred from one project setting to new cost estimations. Broader organizational learning theories or industry-wide benchmarking activities are deemed secondary, unless they directly facilitate project knowledge exchange relevant to cost estimation. This study focuses specifically on learning from previous projects to improve cost estimation accuracy during the tender phase. Other potential benefits of learning, such as schedule adherence, quality control, or safety outcomes, as well as other learning mechanisms like formal training or external benchmarking, fall outside the scope of this research.

5. Organizational Boundaries
The primary units of analysis include internal departments of one contractor.

6. Methodological Limitations
The empirical component of this thesis, including interviews and cost analysis of projects, narrows its scope to recently finished projects for which data can be feasibly collected.

7. Exclusions
The thesis does not address highly specialized technical methodologies beyond the sphere of standard cost estimation processes. For instance, advanced simulation techniques or machine-learning tools (Artificial Intelligence), while potentially beneficial for cost management, are outside the scope.

1.6. Cost-Estimation Process at the Graduation Company

Understanding the internal cost-estimation process at the graduation company is essential to contextualize how learning from previous projects does—or does not—take place in practice. This section provides an overview of how the graduation company, a large Dutch road infrastructure contractor, handles incoming project requests and develops cost estimates. For clarity, a list of frequently used terms and Dutch abbreviations can be found in the Glossary. The process is centralized under the responsibility of the head of the project office and follows a structured sequence from intake to handover to execution.

From Request to Go/No-Go Decision

All incoming project requests, whether public tenders or private requests, are initially received and registered by the head of the project office. Public tenders are monitored daily via TenderNed and noted in a centralized OneNote system accessible to the management team (MT). Each Monday, this team reviews all opportunities and makes a go/no-go decision, guided by factors such as alignment with core competencies (e.g., asphalt works), historical collaboration experiences, and strategic fit. If an opportunity is rejected, it is archived with a documented rationale for future reference.

Initiation of Cost Estimation

For the tenders chosen by the MT, a cost-estimation page is created in SharePoint, and the work is assigned to one or more cost estimators and possibly tender managers, depending on the type of tender (e.g., lowest price vs. EMVI). Weekly planning meetings ensure balanced workload distribution. Cost estimators handle all elements of the cost estimation: requesting supplier quotes, checking quantities, and preparing draft budgets.

Quality Control and Decision-Making

Each draft budget undergoes a mandatory four-eyes check, typically by a senior cost-estimator or the head of the project office, to mitigate cognitive bias and improve reliability. All identified comments must be addressed by the cost estimator, ensuring traceable and deliberate decision-making.

Subsequently, the identified team members hold a final tender pricing meeting, including the project or operations manager, and possibly, the managing director. Here, the team uses past tender outcomes and market data to determine the final bid amount ("schrijfcijfer"). The cost-estimator then prepares the definitive tender budget accordingly.

Final Submission and Handover

Before submission, all tender documents are reviewed under the four-eyes principle to verify completeness and compliance. Once submitted and awarded, a structured handover is conducted with the execution team. This mirrors the earlier pricing meeting but includes additional stakeholders such as the site manager and buyer ("Inkoper"), ensuring continuity and operational readiness.

Project Evaluation

All projects should be evaluated within one month after completion. For longer-running projects (over six months), interim evaluations are advised. Evaluations may cover topics such as client satisfaction, Key Performance Indicators (KPIs), supplier performance, compliance with tender commitments, resource use, environmental factors (e.g., complaints), process control, and team functioning. Projects exceeding an initial contract sum of €700,000 are always evaluated. Additionally, at least 1 in 20 projects between €50,000 and €700,000 is evaluated.

1.7. Thesis outline

Figure 1.1 presents the structure of this thesis. Following this introduction:

- Chapter 2 details the research methodology.
- Chapter 3 reviews relevant literature.
- Chapter 4 presents the empirical results.
- Chapter 5 discusses findings and proposes a framework.
- Chapter 6 concludes the study.
- Chapter 7 gives recommendations and outlines limitations.

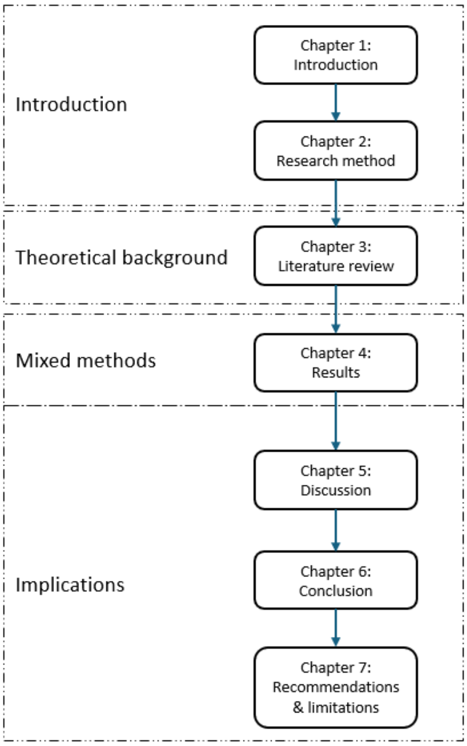

Figure 1.1: Thesis structure overview

2
Research Method

2.1. Research Design

This research focuses on a single company, enabling deeper access to internal practices and informal learning dynamics often unavailable in multi-case studies, an essential consideration for studying learning from previous projects, which is inherently context-specific.

This study adopted a mixed-methods research design using an explanatory sequential approach. It began with a quantitative analysis of cost deviation data, followed by qualitative interviews to interpret the underlying causes of the observed patterns (Creswell & Clark, 2007). This integration leverages the strengths of both approaches: quantitative data reveals trends, while qualitative data adds depth, context, and explanatory insight (Yin, 2014).

A literature review was conducted prior to the empirical phases to frame the research questions and identify known barriers and enablers of organizational learning. This informed both the interview guide and the focus of the cost deviation analysis. The mixed-methods design was well suited to the study's aim of understanding how and why knowledge from past projects affects cost estimation accuracy (Hartmann & Dorée, 2015).

The mixed-methods approach also helped offset the limitations of using a single method; for example, statistical cost analyses alone might lack contextual insight, while interviews alone could be anecdotal. Combining both enhanced validity through triangulation (Van Griensven et al., 2014). Research question 1 (RQ1) was addressed in the literature review, while research questions 2 (RQ2) and 3 (RQ3) were explored through the quantitative and qualitative analyses. The link between the methods can be seen in 2.1.

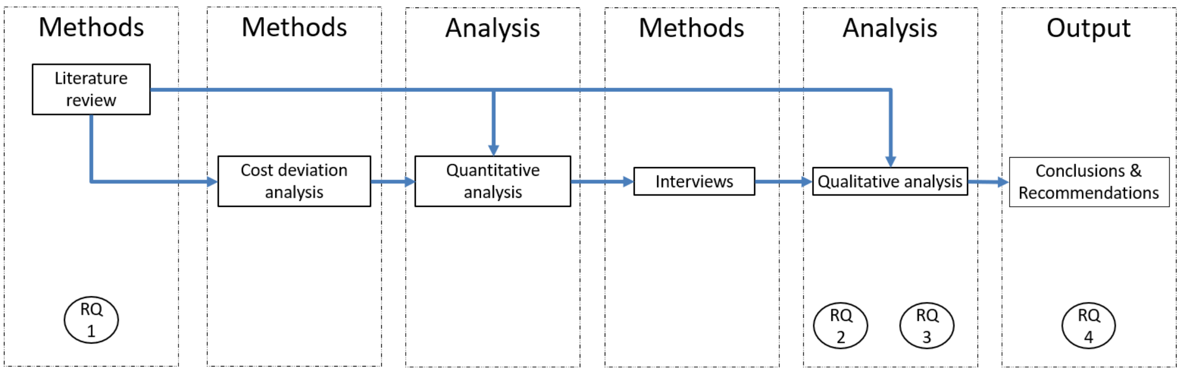

Figure 2.1: Research design used in this thesis

Patterns identified in the quantitative phase informed the interview protocol. Referring to specific project cases helped elicit more targeted responses on why deviations occurred and whether learning took place.

2.2. Quantitative Methods

2.2.1. Cost Deviation Analysis

The quantitative component consisted of a cost deviation analysis focused on staff-related costs in completed road projects from the local branch of the graduation company. Staff costs were chosen as the main focus for cost deviation analysis because they are included in every project budget and are consistently recorded in the company's financial systems. Additionally, the financial control team at the graduation company suspected, based on anecdotal evidence and internal discussions, that staff costs might be a frequent source of budget overruns. While this was not a confirmed trend, their observation provided a plausible starting point for further investigation. The analysis explored the relationship between estimated and actual staff costs and their deviation relative to the project budget.

Financial data were gathered from 18 completed projects the sampling strategy can be found in 2.4. The analysis particularly emphasized the percentage deviation in staff costs, adjusted to account for extra work, to evaluate the accuracy of the initial estimations.

For each of the selected projects, the following data was gathered:

- Estimated staff (office and technical staff) planning
- Actual staff hours
- Original contract value
- Agreed extra work orders (additions and deductions)
- Net extra work percentage
- Final contract sum (including variations)
- Estimated staff costs as a percentage of the initial contract value
- Actual staff costs as a percentage of the final contract value
- Budget deviation adjusted for variation orders (in %)

To identify trends and potential systematic issues in estimation practices, scatter plots were created to visualize correlations between variables such as contract size, net extra work percentage, and staff budget deviation. Linear regressions were performed to quantify these relationships, with trend lines plotted and both R2 values and p values calculated. A p-value below 0.05 indicates statistical significance, while an R^2 value above 0.3 suggests practical explanatory power.

This approach aimed to detect broader patterns in estimation accuracy. It showcased whether repeated deviations signaled a lack of learning or reflective practice among cost estimators. The analysis served as a foundation for qualitative exploration, identifying where persistent issues occur in staff cost estimations and guiding deeper inquiry into the reasons behind them. These results can be found in Section 4.1.

2.3. Qualitative Methods

2.3.1. Literature Review

A thorough literature review was undertaken to ground the study in existing knowledge frameworks and cost estimation strategies in construction. This review was comprised of peer-reviewed studies and industry reports on project knowledge transfer, organizational learning, and estimating practices. Insights drawn from the literature review directly informed the subsequent methodologies and ensured the research built effectively upon established knowledge (Webster & Watson, 2002).

2.3.2. Semi-Structured Interviews

To find the human and process aspects behind cost estimation, semi-structured interviews were conducted with selected experts at the graduation company. Semi-structured interviews provided a balance between consistency and flexibility, allowing exploration of cost estimation practices while enabling new themes to emerge (Adeoye Olatunde & Olenik, 2021). An interview guide with predefined open-ended questions ensured that all key topics (such as current estimating practices, use of historical data, knowledge sharing mechanisms, and personal experiences with estimate errors) were covered consistently across sessions. At the same time, interviewers can explore deeper or ask follow-up questions based on the interviewee's responses, allowing new insights to emerge. For the interview protocol see Appendix B.

Interview participants were selected from the 18 projects based on their involvement in cost estimation and delivery (See Section 2.4).

2.4. Sampling Strategy

The sampling strategy employed in this study involves a two-step purposive selection process. Initially, a staff cost deviation analysis was conducted by selecting 18 projects executed under traditional contract types (RAW) from within the graduation company's portfolio. These projects were selected using predefined criteria (see below), aiming to ensure consistency and comparability in terms of contract structure, cost elements, and available documentation. Selection was also informed by the availability of sufficiently complete project data. Time constraints inherent to the thesis timeline limited the total number of projects that could be processed and analyzed in depth, but the resulting dataset provided a representative and diverse sample for qualitative follow-up.

The following selection criteria were applied in order to ensure the reliability and comparability of the dataset:

- Completed project
- Project includes asphalt
- Cost-estimator of the project is still employed at the graduation company
- As much variation in project managers as possible
- Contract form according to RAW specifications
- Availability of initial documentation and working budget
- Diversity of clients (maximum two projects per client)

Based on these criteria, 18 projects were selected from the local branch of the graduation company.

Interviewees were purposefully selected from these 18 projects or the management that oversaw these projects, therefore targeting professionals directly involved in cost estimation, project execution, and tender management. A total of 23 interviews were conducted, with sampling continued until thematic saturation was reached, that is, no substantially new themes were emerging from additional interviews. This iterative approach ensured data relevance and depth (Campbell et al., 2020). In practice, this meant interviewing:

- Cost estimators – to understand how they prepare estimates and whether they use knowledge from previous projects.
- Financial controllers - to discuss any cost monitoring systems that could facilitate learning from previous projects.
- Tender managers - to understand how they approach tenders and whether they use knowledge from previous projects.
- Project managers - to provide insight into how project execution data and lessons are fed back into the estimation process (or where disconnects occur).
- Site managers - to see how they perceive learning and the link between execution and cost estimation.
- Members of the Management Team (MT) - to discuss broader organizational influences on estimation accuracy and learning. Members of the MT are included because they shape the strategic priorities, resourcing decisions, and cultural norms that affect how knowledge is captured and used across projects.

Figure 2.2: Roles of the Interview Participants

This multi-perspective interview strategy ensures that both the operational and organizational dimensions of cost estimation and learning are thoroughly explored.

All participants are professionals (with several years of experience in the company or industry), so they can reflect on multiple projects and comment on possible patterns. Each interview lasted around 30 to 100 minutes. The interview questions are informed by both the literature review and initial quantitative findings. Follow-up questions encouraged participants to share practical examples or experiences. All interviews were recorded (with consent), transcribed, and used to explain quantitative patterns as well as practical factors influencing cost estimation accuracy.

2.5. Limitations

It is important to acknowledge the limitations of the chosen methodology, particularly regarding scope and generalizability. First, the study relied on data from a single company, the graduation company, operating in the Dutch (road) construction sector. Therefore, the insights and conclusions drawn are context-specific to the graduation company's organizational culture, processes, and project types. Although many challenges of cost estimation and knowledge transfer are likely common across construction firms, any particularities unique to the graduation company (such as its internal knowledge management practices) could limit the direct applicability of results to other organizations. Second, while this focused approach facilitated in-depth analysis, it may have excluded certain perspectives present in a larger, more diverse group of contractors. However, the results showed insights into the road construction industry and its cost estimation practices. These limitations are noted so that readers may appropriately interpret the scope and applicability of the study's findings.

2.6. Data Analysis

Data Gathering Procedures

All data were gathered in a manner consistent with TU Delft ethical research standards. Prior to the interview, each participant received an information sheet and consent form explaining the study's purpose, the voluntary nature of participation, and the measures taken to protect their privacy. Informed consent was obtained, and participants were assured of their right to withdraw at any point. Interview recordings and transcripts were stored securely with restricted access, and all identifying details were removed or coded to ensure anonymity. Participants received a copy of their transcripts for acceptance. Project documents provided by the graduation company were treated as confidential and any sensitive numerical data were aggregated or masked in the write-up. These precautions are essential to build trust, encouraging participants to share insights openly.

Quantitative Analysis

Project cost data were analyzed using descriptive statistics. For each recurring work item, the deviation percentage was calculated and then aggregated to determine the average deviation. Where data permitted, correlation analyses were conducted to examine trends across projects. The quantitative results were organized and visualized with the use of MS Excel. The results informed the qualitative phase. Any observed trends were compared against qualitative themes to provide a comprehensive understanding of whether and how learning from previous projects has influenced estimation accuracy.

Data Analysis Approach

To investigate the relationship between staff costs and key project variables, the financial data of 18 completed projects were subjected to a quantitative analysis. The dataset reflects a diverse sample based on project type, client, and responsible personnel. Given the small sample size (n = 18), the analysis did not aim to provide definitive conclusions but rather to identify potential patterns and indications worthy of further exploration. Quantitative patterns were visualized and statistically analyzed, as described in Section 2.2.

Qualitative Analysis

Interview transcripts were thematically coded by the researcher using the Gioia methodology (Gioia, 2021), starting with open coding to label first-order concepts. These are informant-centric terms or phrases that closely reflect what interviewees actually said, such as “Project evaluations have gone to the wayside the last few years, and we need to change that” was coded as ”Make project evaluations (again) a standard required step”. Subsequently, these first-order concepts are grouped into broader second-order themes. These are researcher-centric categories that help reveal patterns or theoretical insights, such as “Institutionalize evaluation”. Finally, these themes are synthesized into aggregate dimensions, which represent higher-level constructs that answer the research questions.

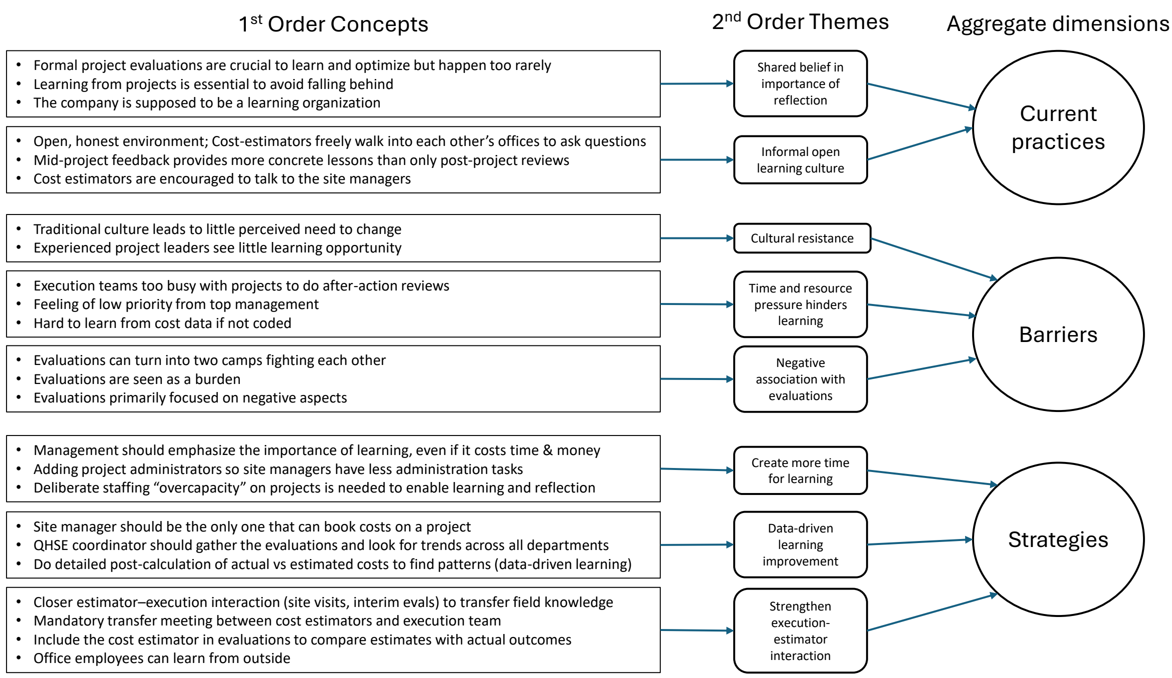

Figure 2.3: Bottom-up analysis with Gioia

While the coding process followed an inductive logic consistent with the Gioia methodology, the aggregate dimensions were subsequently interpreted in relation to the central research questions. This interpretive step occurred after the bottom-up coding process and was not pre-structured or deductively imposed. The link between dimensions and research questions reflects an effort to synthesize emergent themes into a coherent analytical framework. As noted by Gioia (2021), the final dimensions often serve as a bridge between informant-grounded insights and theoretical relevance. Therefore, the structure of the findings is grounded in empirical data while also organized to meaningfully address the study's central aims.

Cellphone-recorded interviews were transcribed verbatim using Turboscribe.ai and refined with ChatGPT to remove conversational fillers, improving readability without altering meaning. However, to preserve the accuracy and intended meaning of participants' responses, the revised transcripts were carefully reviewed alongside the original audio recordings. Qualitative coding and theme development were conducted manually in Excel. Codes and themes were tracked using structured spreadsheets, enabling systematic comparisons across transcripts. This tool-supported structure also allowed linking quotations to first-order concepts and second-order themes.

A key principle of the Gioia methodology is its emphasis on the meaning and context of what is said, rather than the frequency with which a theme appears. Therefore, the analysis prioritizes the conceptual richness of each instance over its numerical recurrence. This aligns with the inductive nature of the approach, where insights emerge from the data itself rather than being imposed by existing theory.

After conducting and transcribing approximately ten interviews, a preliminary categorization of first-order instances into second-order themes was developed. From that point onward, theoretical sampling was applied in a broad sense: greater attention was paid to underexplored or newly-emerging themes during subsequent interviews. This adaptive approach enabled a more nuanced understanding of the phenomena under investigation and ensured that the coding process remained responsive to new insights. The interview questions can be found in Appendix B – Interview Protocol.

2.7. Reliability and Validity

Ensuring the reliability and validity of the research findings was critical, especially given the mixed-methods design. Several measures were implemented to enhance trustworthiness. For reliability, a pilot interview was conducted with a cost estimator outside the main sample to refine the interview guide. The interview protocol was reviewed by the first supervisor and the company supervisor prior to data collection. Their feedback led to several refinements in question phrasing and structure, ensuring alignment with both academic rigor and practical relevance. A consistent protocol was used during data collection, including standardized questions, similar sequencing across interviews, and uniform transcription practices.

Validity was enhanced through data triangulation: quantitative results informed the qualitative phase and were later cross-checked against interview findings. The interview guide was partially informed by early insights from the cost deviation analysis and literature review. This ensured alignment between empirical observations and interview prompts, increasing construct validity. As the coding was conducted by a single researcher, there was a risk of subjective interpretation influencing theme development. While efforts were made to remain grounded in the participants' phrasing through the Gioia methodology, the absence of inter-coder comparison or formal memoing limits the mitigation of researcher bias. This should be considered when interpreting the qualitative results.

2.8. Alignment with Research Objectives

The methodology described above is tightly aligned with the overall research objective of understanding how learning from previous projects can improve cost estimation accuracy in the Dutch road construction industry. The quantitative cost deviation analysis directly assessed the extent of cost estimation inaccuracies and identified patterns that may indicate learning, or its absence, across projects. Meanwhile, the qualitative phase investigated how knowledge transfer is achieved, what barriers exist, and how practices could be improved.

By integrating both numeric and narrative data, the methodology not only identified "what" and "where" cost estimation issues exist but also probed “how” and “why” these issues occur. This integrated approach ensured that each research question was addressed, ultimately leading to evidence-based recommendations for implementing effective learning from previous projects.

3

Literature review

3.1. Purpose, Method and Outline

The purpose of this literature review is to systematically identify, assess, and synthesize existing research related to cost overruns, cost estimation theory & learning theories in cost estimation. Guided by the systematic review methodology outlined by (Tsafnat et al., 2014) as is shown in Figure 3.1, this literature review will clarify theoretical and practical gaps, informing a robust basis for empirical investigation.

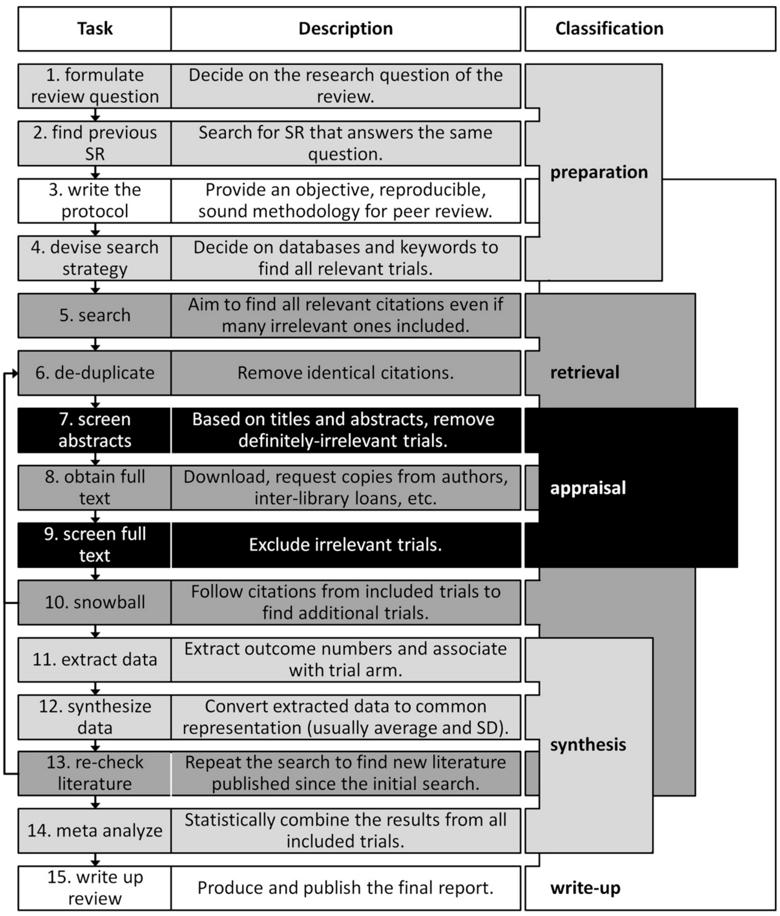

Figure 3.1: Steps of the systematic review (Tsafnat, 2014)

The following keywords were used to find peer-reviewed academic articles:

- Cross-project learning
- Inter-project learning
- Knowledge transfer
- Cost estimation accuracy
- Dutch road construction
- Organizational learning
- Lessons learned processes
- Barriers and enablers learning
- Project-based organizations
- Infrastructure cost overruns
- Cost deviation analysis
- Construction knowledge management

The literature review starts with an overview of cost overruns in the construction industry to establish context. It then delves into detailed analyses of cost overruns and deviations to understand their occurrence and contributing factors. Next, it explores knowledge management and learning within construction projects, emphasizing cross-project learning and identifying barriers and drivers influencing effective knowledge transfer. Finally, the review concludes by assessing current practices, tools, and methodologies aimed at reducing cost overruns, thus logically connecting theoretical insights to practical applications.

3.2. Cost Overruns in the Construction Industry

Cost overruns in infrastructure projects are quite common, despite extensive research into their causes (Cantarelli, Molin, et al., 2012; P. E. Love et al., 2015; Molinari et al., 2023; Tan & Makwasha, 2010). Academic research has consistently documented that a large majority of infrastructure projects, from road and rail to fixed links such as bridges and tunnels, are completed at costs significantly higher than predicted (Cantarelli, Molin, et al., 2012; Molinari et al., 2023).

As mentioned in Section 1.1, cost overrun is expressed as:

Cost Overrun (%) = [(Actual Cost − Estimated Cost) / Estimated Cost] × 100

This metric captures not only budgetary discrepancies but also the degree of uncertainty inherent in infrastructure investments. Peer-reviewed studies have repeatedly shown that such overruns are not abnormalities; rather, they are systematic occurrences that happen across different types of infrastructure projects. For example, analyses of road and rail projects in various European contexts indicate that the frequency of projects with overruns often exceed 80%, with studies mentioning cost overruns averages ranging from 20% to 60% (Molinari et al., 2023; Odeck, 2004).

Types of Infrastructure Projects Affected

Table 3.1 summarizes the frequency and magnitude of cost overruns reported for different transport modes in European studies. These findings confirm that overruns are widespread across all project types, though with variation in magnitude.

Project Type	**Frequency of Overruns (%)**	**Average Overrun (%)**
Road	∼80%–90%	20%–30%
Rail	∼85%–95%	40%–50%
Fixed Links (Bridges/tunnels)	∼75%–85%	30%–40%

Table 3.1: Cost overrun characteristics in European infrastructure projects. Adapted from (Cantarelli, Molin, et al., 2012).

Thus, the consistent presence of overruns across these project types suggests that the challenge is embedded in the forecasting and execution processes common to infrastructure rather than being an artifact of project-specific issues.

Road Infrastructure Projects

More specifically, examining the unique characteristics of road infrastructure projects offers deeper insights. Cost overruns in road construction show several characteristic patterns. One key observation is their magnitude and frequency. Studies indicated that road projects typically experience overruns between 10% and 30%, with some exceeding 50% in extreme cases (Flyvbjerg et al., 2004; Herrera et al., 2020). Table 3.2 provides an overview of typical cost overrun magnitudes in road projects compared to other infrastructure types.

Study	Road (Avg. Overrun)	Comparative Figures
(Flyvbjerg et al., 2004)	20%	Rail: 45%; Bridges/Tunnels: 34%
(Cantarelli, Van Wee, et al., 2012)	18.6%	Rail: 10.6%; Fixed Links: 21.7%
(Herrera et al., 2020)	17.5%	Infra sector average: 25%
(Catalão et al., 2021)	18%	Other transport: 60%

Table 3.2: Cost overrun magnitudes in road vs. other infrastructure projects

Geographical Variation: The Netherlands vs. Worldwide

An important insight into cost overrun performance is provided by (Cantarelli, Flyvbjerg, & Buhl, 2012), who examined geographical variation in project cost performance. Their study found that while cost overruns are a global phenomenon, the magnitude varies significantly with location. In particular, for road and tunnel projects, Dutch performance is comparable to worldwide figures. However, for rail and bridge projects, the Netherlands exhibits substantially lower overruns. Given that this thesis focuses on Dutch road construction, it is crucial to note that Dutch road projects tend to perform similarly to those in other countries. This geographical nuance reinforces that, while the Netherlands does not necessarily excel in road project cost performance compared to the global average, it does achieve better results in other infrastructure categories (Cantarelli, Flyvbjerg, & Buhl, 2012).

Historical Development of Research on Cost Overruns

Finally, to properly contextualize cost overruns in their current form, it is vital to understand the historical evolution of research on this topic. Early research in the 1970s and 1980s focused on case studies and anecdotal evidence. In the 1990s, scholars like (Nijkamp & Ubbels, 1999) began analyzing project databases, though findings were inconsistent. A major breakthrough occurred in the early 2000s when (Flyvbjerg et al., 2002, 2004) conducted the first large-scale statistical study, demonstrating that cost overruns are systematic and pervasive across transport infrastructure. Their work introduced theories of optimism bias and strategic misrepresentation, fundamentally shifting the discussion. Since the 2010s, research has expanded to explore contextual and macroeconomic determinants, such as governance quality and political cycles (Catalão et al., 2021). More recent studies focus on big data analysis and reference class forecasting, leveraging past project data to improve cost predictions (Sheamar et al., 2024).

These estimation challenges highlight that errors are not just due to technical complexity but may also come from organizational routines and human decision-making. Understanding why certain cost components are systematically misjudged requires examining how knowledge from past projects is (not) used in future estimates.

3.3. Causes for Cost Overruns in the Construction Industry

Cost overruns in road infrastructure projects arise from a variety of factors, which can be categorized into technical, managerial, financial, political, and environmental causes (Flyvbjerg, 2021; Flyvbjerg et al., 2018; P. E. D. Love & Ahiaga-Dagbui, 2018; Verweij et al., 2015). Table 3.3 summarizes these categories along with key examples.

Category	Examples of Causes	References
Technical	Design changes, unforeseen site conditions, scope creep	(Cantarelli, Van Wee, et al., 2012; Cantarelli et al., 2013; Herrera et al., 2020; P. E. D. Love & Ahiaga-Dagbui, 2018; Verweij et al., 2015)
Managerial	Poor planning, inadequate risk management, procurement issues	(Durdyev, 2021; Herrera et al., 2020; P. E. D. Love & Ahiaga-Dagbui, 2018; Verweij et al., 2015)
Financial	Price inflation, funding shortfalls, cash flow delays	(Catalão et al., 2021; Herrera et al., 2020)
Political	Optimism bias, strategic cost underestimation, election-driven priorities	(Flyvbjerg, 2021; Flyvbjerg et al., 2004; Herrera et al., 2020)
Environmental	Weather conditions, regulatory changes, community opposition	(Herrera et al., 2020; Sheamar et al., 2024)

Table 3.3: Key categories of cost overrun causes in road infrastructure projects

Behavioral Biases in Project Management

Managerial inefficiencies, including poor project planning, cost estimation inaccuracies, and inadequate risk management, significantly contribute to cost overruns (Durdyev, 2021; Herrera et al., 2020). Importantly, Flyvbjerg (2021) expands on this by identifying behavioral biases, shown in Table 3.4, as critical factors that distort project planning and decision-making.

Name of Bias	Description
Strategic misrepresentation	Deliberate distortion of information to influence decisions, often for political or strategic reasons.
Optimism bias	Overestimating benefits and underestimating risks or costs.
Uniqueness bias	Belief that one's project is unusually different from others, leading to flawed assumptions.
Planning fallacy	Underestimating time and cost while overestimating benefits during planning.
Overconfidence bias	Placing excessive trust in one's predictions or expertise.
Hindsight bias	Seeing past events as more predictable than they were; the "I-knew-it-all-along" effect.
Availability bias	Judging probabilities based on readily available information instead of objective data.
Base rate fallacy	Ignoring statistical averages in favor of anecdotal evidence.
Anchoring	Relying too heavily on initial information when making decisions.
Escalation of commitment	Continuing a failing course of action due to past investments (sunk cost fallacy).

Table 3.4: Top ten behavioral biases in project management (Flyvbjerg, 2021)

Key Factors in Road Project Overruns

Herrera et al. (2020) conducted a detailed analysis of cost overrun factors. Table 3.5 presents the most influential ones ranked by relative frequency and influence index (II).

Category	Factor	Stakeholder Group	Rel. Freq.	Freq. Rank	Infl. Rank
Design	Failures in design	Designer/Consultant	12.78	1	1
Design	Design changes	Designer/Consultant	4.44	5	5
Contractor	Inadequate experience	Contractor	2.78	11	12
Contractor	Poor site management	Contractor	3.33	7	13
Site	Poor site investigation	Designer/Consultant	2.22	17	15
Personal	Staffing problems	Contractor	2.78	11	18
Site	Ground conditions	Designer/Consultant	2.22	17	19
Contract	Poor contract mgmt	Contractor	1.67	22	21
Contractor	Inadequate methods	Contractor	1.67	22	21
Financial	Contractor financial issues	Contractor	2.22	17	24
Materials	Material shortages	Supplier/Subcontractor	1.67	22	25
Contractor	Activity delays	Contractor	1.11	29	30
Personal	Low labor productivity	Contractor	1.11	29	31
Equipment	Equipment shortage	Supplier/Subcontractor	0.56	33	35
Consultant	Late decisions	Designer/Consultant	0.56	33	36
Site	Utility relocation	Designer/Consultant	0.56	33	36

Table 3.5: Cost overrun factors by stakeholder and influence index (Herrera et al., 2020)

Stakeholder Influence in Cost Overruns

Table 3.6 shows which stakeholder groups involved in the execution of the project have the most influence on cost overruns, based on the Stakeholder Influence Index (SII) by Herrera et al. (2020).

Stakeholder Group	SII (%)
Designer and Consultant	40.51
Owner	28.45
External Agent	23.32
Contractor	7.07
Supplier and Subcontractor	0.66

Table 3.6: Stakeholder Influence Index (SII) (Herrera et al., 2020)

Academic Debate on Cost Overrun Causes

Within the literature on cost overruns in road infrastructure projects, two major schools of thought dominate: the *Evolutionist view* (P. E. D. Love & Ahiaga-Dagbui, 2018) and the *Psycho-strategic view* (Flyvbjerg, 2021).

The Evolutionist perspective, as proposed by P. E. D. Love and Ahiaga-Dagbui (2018), argues that cost overruns result from genuine complexities, unforeseen changes, and managerial errors. This school of thought emphasizes that technical and planning challenges—not deliberate manipulation—drive inaccuracies. According to this view, forecasting limitations are inherent in current industry practices.

In contrast, the Psycho-strategic view, championed by Flyvbjerg (2021) and Flyvbjerg et al. (2018), attributes cost overruns to deliberate political and cognitive biases. Flyvbjerg introduces concepts like *strategic misrepresentation*—intentionally low cost estimates to secure approvals—and *optimism bias*, which causes overconfident forecasting due to the natural human tendency to underestimate risks, costs, and completion times. These biases are seen as systemic and predictable unless actively managed.

P. E. D. Love and Ahiaga-Dagbui (2018) challenges Flyvbjerg's position, arguing that his binary framing of "error vs. lie" oversimplifies the issue. They claim his datasets are flawed and lack contextual diversity. In response, Flyvbjerg et al. (2018) defended their work, highlighting its replication in global datasets and its foundation in behavioral science. They assert that failing to distinguish between symptoms (e.g., scope creep) and root causes (e.g., bias) perpetuates misunderstanding and poor forecasting practices.

Although mechanisms for knowledge reuse exist in theory, they often remain underutilized in practice. This raises the question of how contractor-side decision-making—particularly from estimators and project managers—influences cost accuracy. Are deviations primarily the result of flawed assumptions, honest complexity, or strategic behavior? This underscores the need to explore how knowledge from past cost estimates is transferred between project phases and individuals within organizations.

While much of the current literature—such as Flyvbjerg (2021) and P. E. D. Love and Ahiaga-Dagbui (2018)—focuses on the client's (owner's) role in cost overruns, there are strong indications that similar cognitive and strategic biases are also present on the contractor side. Contractors, like clients, face pressures to 'win' projects in competitive tender environments, which may incentivize optimistic budgeting or underestimating risks to remain price-competitive. Estimators often rely on heuristics or incomplete data under time constraints, creating conditions where optimism bias and anchoring effects are likely to occur. Moreover, internal incentive structures—such as reward systems tied to awarded contracts—can further reinforce biased decision-making.

Therefore, although the behavioral frameworks developed for public sector clients are not always directly transferable, the underlying psychological mechanisms—such as overconfidence, strategic misrepresentation, and information filtering—are likely to operate in both contexts. This thesis specifically investigates how project managers and estimators on the contractor's side perceive and respond to estimation challenges, and whether similar biases or structural limitations are at play.

3.4. Cost Estimation Theory

The previous section identified numerous reasons for overruns, from technical complexities and scope changes to managerial decisions and optimism bias (Flyvbjerg, 2021; Tan & Makwasha, 2010). For example, project managers may fall prey to "future perfect" planning—assuming that everything will go according to plan without disruptions— or even strategic misrepresentation of costs (P. E. D. Love et al., 2015). Such issues highlight a critical need for robust cost estimation practices. Thus, in response, the field of cost estimation theory has evolved to improve accuracy and reliability, directly addressing these root causes of overruns (Liu & Zhu, 2007).

To create a more cohesive overview, this chapter is structured into several interrelated parts. First, it outlines the academic foundations of cost estimation, focusing on its role in infrastructure and the distinction between early-stage and detailed estimates. Then, it reviews estimation methods in practice, including both expert judgment and data-driven techniques. Key concepts like uncertainty and risk are examined next, followed by a historical sketch of how cost estimation research has evolved over time. After that, the influence of organizational and external factors on estimate accuracy is discussed. The chapter concludes with a synthesis of how theory has been applied in practice and the role of learning in improving estimates.

Foundations of Cost Estimation in Infrastructure Construction

Accurate cost estimation is fundamental to project success in infrastructure construction. It provides the basis for budgeting, financing decisions, and project control (Mahamid, 2011). Unlike routine manufacturing, construction projects are unique and one-off, meaning their costs must be predicted before work begins. However, estimators typically distinguish between conceptual (early-stage) estimates and detailed (later-stage) estimates. Early estimates, made with minimal design information, are notoriously imprecise, commonly in the range of 25–50% error (Mahamid, 2011). As a project progresses and more details emerge, estimates become more reliable. A road infrastructure project's cost is influenced by countless variables, many unknown at the outset. Variables, such as ground conditions, weather impacts, productivity rates, and design changes, all contribute to estimation variance.

Estimation Methods

In practice, cost estimation has relied on two broad approaches: expert judgment and data-driven estimation. Expert-based methods depend heavily on the estimator's experience and intuition (Elfaki et al., 2014). Data-driven estimation, by contrast, uses historical cost data and statistical relationships to forecast costs based on comparable projects (Mahamid, 2011). Modern practice often combines these approaches.

Key Concepts: Uncertainty and Risk

A recurring theme in the literature is the distinction between uncertainty and risk in cost forecasting. Uncertainty refers to unknown variability, such as unforeseen site conditions or design changes, while risk is the measurable likelihood of deviation from expected outcomes (Tan & Makwasha, 2010). Because infrastructure projects face many unknowns—especially in early phases—cost estimates should include contingencies or be expressed as ranges rather than fixed values.

Probabilistic estimating has become a recommended approach to better account for this variability. In this method, cost forecasts are expressed in terms of confidence levels. For example:

- P50 represents the estimated cost level where there is a 50% chance the actual cost will be lower and a 50% chance it will be higher.
- P90 represents a more conservative estimate, where there is a 90% confidence the actual cost will not exceed the predicted value.

Using P50 and P90 budgets helps project teams and decision-makers manage expectations and plan for uncertainty, especially in politically sensitive or financially constrained environments (Liu & Zhu, 2007; Tan & Makwasha, 2010).

Evolution of Cost Estimation Research

Research on construction cost estimation has evolved from an early focus on cost drivers (1970s–80s) to systemic views today. Skitmore (Skitmore, 1985) emphasized estimator experience; Akintoye (Akintoye, 2000) added organizational factors. Mahamid (Mahamid, 2011) integrated market dynamics, while Tan and Makwasha (Tan & Makwasha, 2010) explored contingency-setting. Reference Class Forecasting (RCF), developed by Flyvbjerg (Flyvbjerg, 2006), adjusts estimates using historical overrun data. Recent studies (Fazil et al., 2021; Sayed et al., 2020; Simić et al., 2023) include macroeconomic and organizational influences.

Predictability of Project Costs Under Uncertainty

Perfect estimates are rare; most projects deviate from their budgets. Underestimation causes shortfalls; overestimation ties up resources unnecessarily (Mahamid, 2011).

Reference Class Forecasting

RCF uses historical data from similar projects to adjust new estimates (Flyvbjerg, 2006). This method helps mitigate optimism bias and is increasingly adopted in public infrastructure projects.

Managerial and Organizational Factors

Organizational processes heavily influence estimate accuracy. Team competence, decision-making culture, and strategic misrepresentation all play roles (P. E. D. Love et al., 2015). Best practices include stage-gate reviews, checklists, and lessons learned systems (Elfaki et al., 2014; Mahamid, 2011).

External Disruptions and Cost Estimation

Events like Brexit, COVID-19, and the war in Ukraine have introduced volatility, necessitating frequent updates and robust contingency planning (Simić et al., 2023). Estimators now incorporate inflation scenarios and flexible contracts.

Linking Theory to Practice

Table 3.7 summarizes how theoretical frameworks have translated into real-world cost estimation tools.

Framework/Method	Core Concept	Application in Practice	Source
Reference Class Forecasting (RCF)	Use data from similar past projects to correct optimism bias.	Cost databases and contingency multipliers based on historical overruns.	(Flyvbjerg, 2006)
Organizational Control Theory	Shift control types as project definition improves.	Early phase: checklists; later phase: performance monitoring.	(Liu & Zhu, 2007)
Contingency Theory	Match estimation methods to project-specific risks.	More complex projects use larger contingencies and scenario analysis.	(Fazil et al., 2021)

Table 3.7: Connections between cost estimation theories and practical applications

A key example is probabilistic estimating. This theoretical recommendation is now standard in Dutch and UK public projects, where both P50 and P90 estimates are included (Flyvbjerg, 2006). Similarly, Organizational Control Theory shapes the use of phase-gated processes, where early estimates are treated as tentative and revised with new information (Liu & Zhu, 2007).

Toward Learning and Improvement in Cost Estimation

Cost estimation theory has matured into a multidisciplinary field combining technical, managerial, and contextual insights. Frameworks like RCF and Organizational Control Theory help align estimates with outcomes (Mahamid, 2011; Tan & Makwasha, 2010). As the next section explores, learning from previous projects represents the next frontier—translating past lessons into improved estimating practices.

3.5. Learning Theories in Cost Estimation

Recent research suggests that learning, both at the individual and organizational levels, can significantly enhance forecasting accuracy (Fazil et al., 2021; Hartmann & Dorée, 2015). Learning theories originally applied in safety and quality management, thus can and have begun to inform cost estimation practices by emphasizing experiential improvement and systematic knowledge transfer. This section reviews the academic literature on learning in cost estimation, focusing on how experiential and organizational learning theories have been applied in practice, how the research has evolved over time, and the challenges associated with integrating learning into estimation processes. By examining these themes, the review creates a conceptual bridge between traditional cost estimation theory and the emerging framework of cross-project learning.

Key Learning Theories Applied to Cost Estimation

Several learning theories and concepts have been invoked to improve cost estimation practices. Table 3.8 summarizes key learning-related theories and how they apply to construction cost estimation.

Learning Theory	Description	Application in Cost Estimation
Experiential Learning (Kolb, 1984)	Learning as a cycle: experience, reflection, conceptualization, and experimentation.	Estimators refine skills through real projects. Mentorship, on-the-job training, and reflective practices improve accuracy (Lowe & Skitmore, 1994).
Learning Curve Theory	Performance improve predictably with experience.	Repeated project exposure sharpens judgment and reduces error (Flyvbjerg, 2006).
Organizational Learning	Knowledge collection, sharing, and use within firms.	Documented lessons and shared databases reduce bias and support realistic forecasts (Eken et al., 2020).

Table 3.8: Key learning theories and their application in cost estimation

Cross-Project Knowledge Transfer

While individual experience is crucial, organizational learning ensures that lessons from one project inform future projects. Project-based organizations often struggle to retain and transfer knowledge due to their temporary nature. Eken et al. (2020) note that much project knowledge is lost after completion, limiting learning.

To address this, firms have implemented lessons-learned systems and knowledge repositories. These document what went well or poorly, especially in cost estimation assumptions. For example, noting underestimated excavation costs in Project X helps inform future similar projects. Categorizing past projects by type, size, or location improves retrieval and relevance.

However, simply capturing data is insufficient—organizational culture must support its use. As Chan et al. (2023) show in safety management, leadership and openness are key to turning data into action. Likewise, cost management must encourage transparent, non-blaming reviews of estimates to improve future performance.

Integrating Learning from Safety and Quality into Cost Management

Learning across projects parallels practices in safety and quality, such as the Plan-Do-Check-Act (PDCA) cycle (Taylor et al., 2014). Cost estimation can apply the same cycle:

- **Plan:** Develop estimates based on data and assumptions.
- **Do:** Monitor costs during project execution.
- **Check:** Compare actual vs. estimated costs.
- **Act:** Integrate lessons and adjust cost models.

Berg et al. (2025) recommends treating estimating as iterative and managing historical data systematically to support learning.

Evolution of Research on Learning in Cost Estimation

Research has evolved from early conceptual works (e.g., Lowe and Skitmore (1994)) to a focus on behavioral biases (Flyvbjerg et al., 2002) and more recently, knowledge transfer and organizational learning (Ahiaga-Dagbui & Smith, 2014; Hartmann & Dorée, 2015).

Fazil et al. (2021) conducted a 31-year review and proposed using organizational and contingency theories to better explain estimation performance. This unifying framework accounts for context, experience, and feedback mechanisms.

Evolution of Organizational Learning Frameworks

Crossan et al. (1999) introduced the **4I framework** (Figure 3.2) of organizational learning, defining four key learning processes: *intuiting*, *interpreting*, *integrating*, and *institutionalizing*. These "4Is" link learning across three levels—individual, group, and organizational (Crossan et al., 1999). Intuiting begins with individuals recognizing patterns or novel ideas from personal experience. Interpreting involves refining and sharing these insights within a group, developing collective understanding (Crossan et al., 1999). Integrating and then embedding this new knowledge into group routines or practices, aligning it with the broader organization. Finally, institutionalizing incorporates the learning into organizational systems, procedures, or strategies so that it becomes part of the institution's memory (Crossan et al., 1999). Thus, the 4I framework illustrates how individual insights feed forward into organizational knowledge, while institutional memory feeds back to shape new learning.

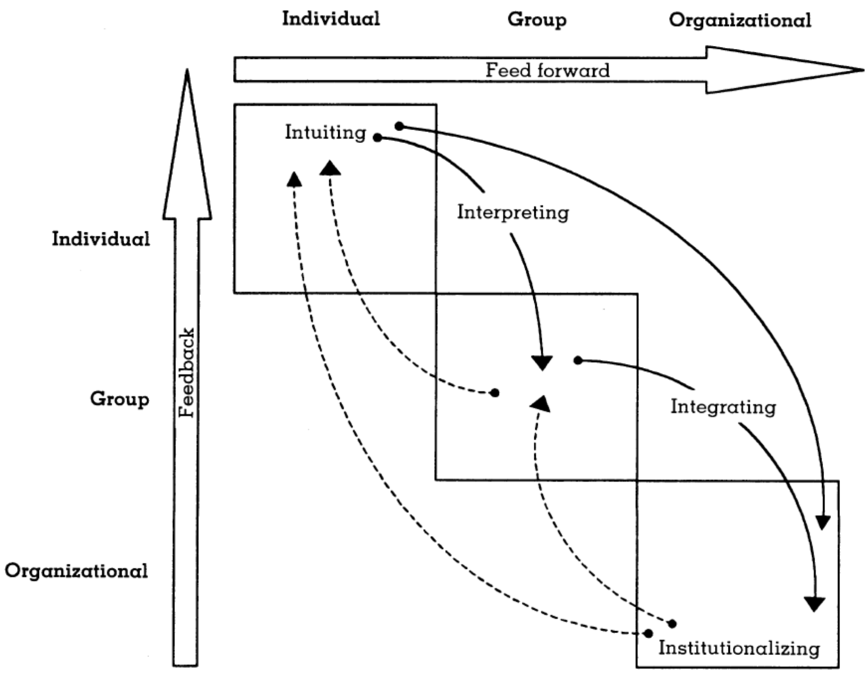

Figure 3.2: The 4I Organizational Learning Framework by Crossan et al. (1999)

Building on this foundation, Jenkin (2013) proposed an extended **5I model** (Figure 3.3) that adds a fifth process, *information foraging*, and introduces a new "tool" level to the framework. This addition addresses how individuals and groups actively search for and acquire external information that can stimulate intuiting (Jenkin, 2013). The information foraging process captures deliberate scanning and searching—drawing on data repositories, documents, or other knowledge sources—to find relevant insights, often with the aid of technology. By recognizing a dedicated tool level (e.g., databases, software, repositories), the 5I model highlights the role of information systems in supporting learning at all levels (Jenkin, 2013). Jenkin's extension builds directly on the 4I framework by responding to the increasing importance of data-driven learning and the practical use of digital tools in organizational knowledge processes.

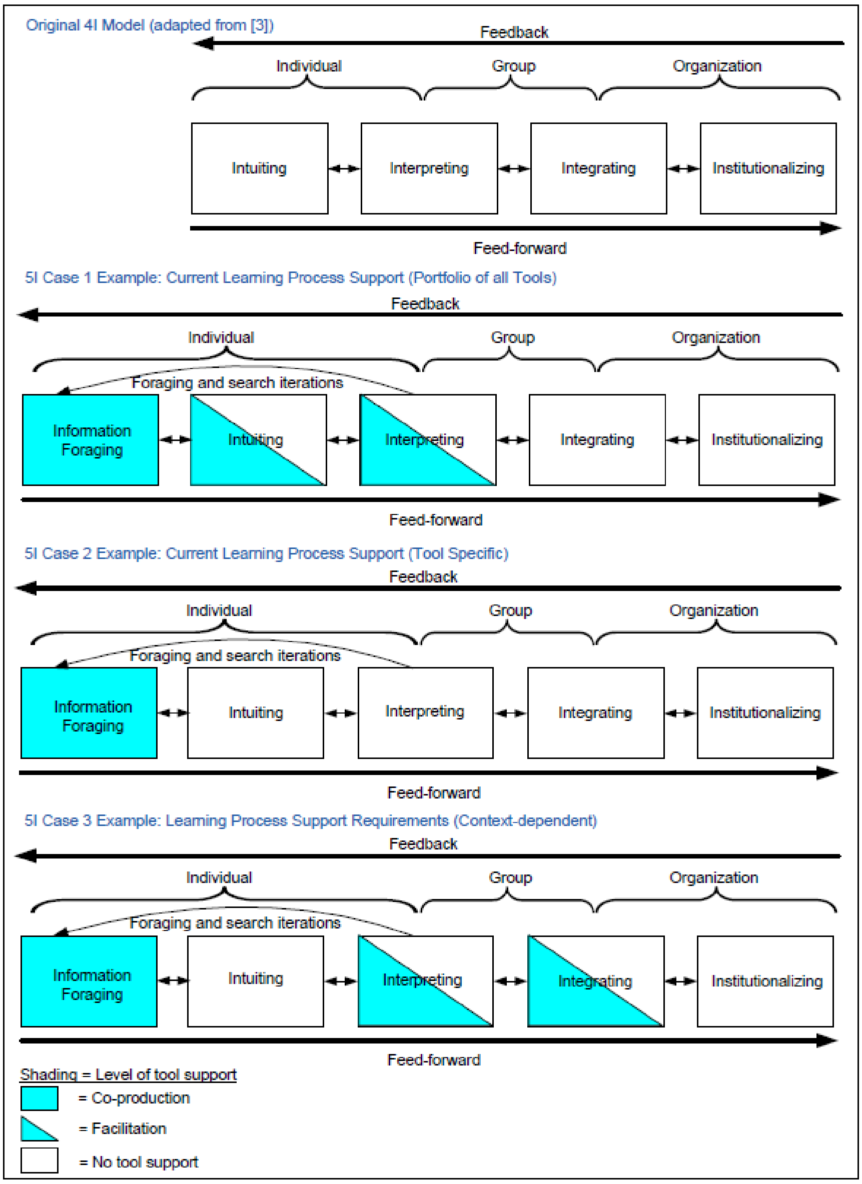

Figure 3.3: The 5I Organizational Learning Framework by Jenkin (2013)

Most recently, Wodnik et al. (2024) expanded the model further to a **6I framework** (Figure 3.4) to account for interorganizational learning. In addition to the original processes (and Jenkin's information foraging), two new processes—*interaction* and *incorporation*—are introduced to capture learning that occurs across organizational boundaries (Wodnik et al., 2024). *Interaction* refers to the exchange and co-creation of knowledge through partnerships, alliances, or communities of practice between organizations. *Incorporation* describes how organizations absorb knowledge from, and contribute knowledge to, broader coordinating bodies or networks, linking organizational learning to a higher system level (Wodnik et al., 2024). The 6I model effectively adds two levels beyond the single organization: one for peer or partner organizations and another for overarching coordinating entities. By including these interorganizational dimensions, the 6I framework emphasizes that learning is not confined within one firm but also involves knowledge flows between firms. Furthermore, the model introduces both social psychological and social political processes to explain how knowledge is accepted, challenged, or blocked within and between organizations. Social psychological processes highlight how individual cognition, group dynamics, and shared meaning-making influence the progression of learning. Social political processes account for power relations, resource control, and institutional interests that affect whether new insights are embraced, resisted, or suppressed.

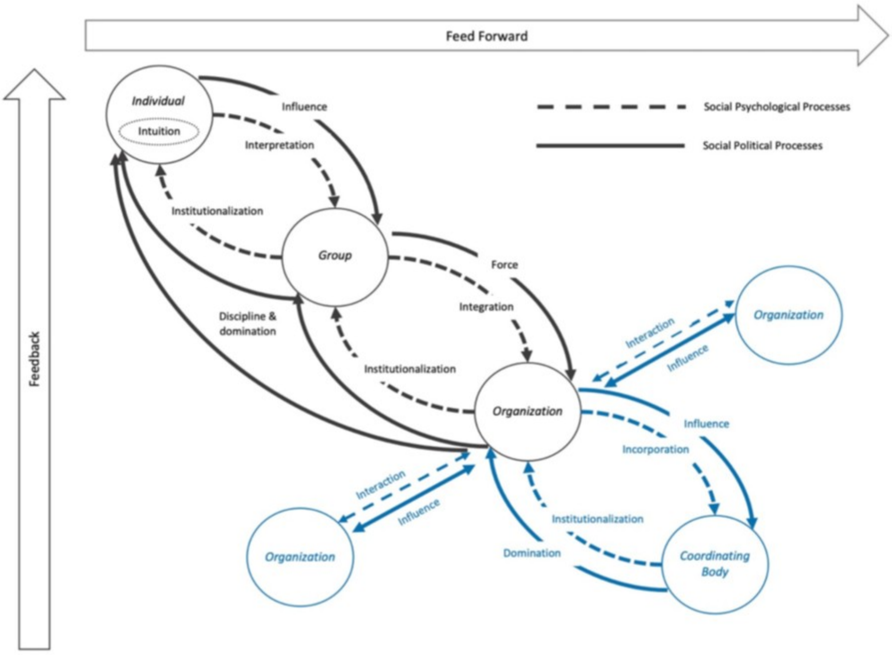

Figure 3.4: The 6I Interorganizational Learning Framework by Wodnik et al. (2024)

This evolution from 4I to 5I/6I demonstrates a widening scope for organizational learning: from internal multilevel processes, to incorporating technological tools and external information, and finally to network-level learning among organizations. Each extension builds logically on its predecessor, first integrating the role of knowledge search and digital tools, then extending beyond organizational boundaries to the broader ecosystem. Such developments are particularly relevant in infrastructure project contexts, where multiple stakeholders (contractors, agencies, consultants, etc.) must learn from past projects. Lessons learned in one project need to be captured (via processes and tools) and shared across organizations so that future projects can benefit from past experience. The 5I and 6I frameworks support this need by providing mechanisms for systematic knowledge capture and cross-organizational transfer, underscoring the importance of learning from past projects to improve long-term outcomes in the infrastructure sector.

Tools to Enhance Forecasting Accuracy

- **Post-Project Reviews:** Compare estimates to actuals, identify causes, and adjust databases and methods (Ahiaga-Dagbui & Smith, 2014).
- **Historical Databases:** Store project-specific cost data indexed by scope and context (Berg et al., 2025).
- **Communities of Practice:** Encourage peer learning and mentoring to share tacit knowledge (Kululanga et al., 2001).

Conclusion and Implications

Effective cost estimation depends not only on models and data but also on how organizations learn from previous projects. Research shows that learning-oriented organizations achieve better forecasting outcomes (Ahiaga-Dagbui & Smith, 2014). Bridging estimation theory with learning helps reduce cost variances and supports more resilient planning.

3.6. Cross-Project Learning in Cost Estimation

The previous section demonstrated that applying learning theories to cost estimation can significantly enhance project outcomes. It established that individual and organizational learning, when systematically integrated, reduces the risk of cost overruns. Cross-project learning offers a solution by transferring and institutionalizing lessons learned across projects, thereby preventing the repetition of past mistakes. This section reviews the academic literature on cross-project learning, examining key theories, frameworks, and approaches.

Theoretical Foundations

A key theoretical perspective for understanding the difficulties of cross-project learning is the view of projects as temporary organizations. Lundin and Söderholm (1995) and Packendorff (1995) describe projects as inherently time-limited, goal-driven, and short-lived, which makes it challenging to build and retain organizational knowledge over time. Unlike permanent structures, project teams disband after delivery, and the knowledge they generate often remains with individuals or within informal conversations, rather than being embedded in formal systems. This structural impermanence disrupts continuity and limits the transfer of lessons between projects. As a result, insights gained during one project are frequently lost, underutilized, or disconnected from future efforts.

Cross-project learning is rooted in the broader domains of organizational learning and knowledge management. Crossan et al. (1999) argue that an organization truly learns only when individuals reintegrate their insights into the system and when supportive structures exist to embed this learning. In project-based organizations (PBOs), however, learning often remains confined within projects because teams are disbanded at the project's end (Newell, 2004). This "learning paradox" highlights a central problem: while projects generate valuable knowledge, the lack of effective transfer mechanisms means that each new project starts from scratch.

Key Frameworks and Approaches

Several frameworks facilitate cross-project learning:

Approach	Description and Key Features
Lessons learned reviews	Formal reviews at project milestones to capture actionable insights. Require follow-up to be effective (Newell, 2004).
Knowledge repositories	Centralized databases for project knowledge. Need consistent data entry and user engagement (Flyvbjerg, 2006).
Data-driven learning	Quantitative methods like reference class forecasting. Depend on quality and contextual fit of data (Flyvbjerg, 2006).
Project Management Office (PMO)	Central unit standardizing methods and sharing knowledge. Works best with strong team support (Julian, 2008).
Communities of practice	Informal peer groups that share tacit insights. Require cultural support (Wiewiora et al., 2010).
Staff rotation	Moves people across projects to share knowledge. Effective but may reduce team cohesion (Paver & Duffield, 2019).

Table 3.9: Overview of cross-project learning approaches in literature

Evolution of Research

Initial studies advocated for formal mechanisms. Later, researchers emphasized the cultural and contextual enablers of learning. Ferres and Moehler (2023) introduced "concrete boundary objects" to standardize knowledge transfer. Hartmann et al. (2023) emphasized structured reflection sessions for learning. These studies underline that effective learning must go beyond documentation to engage teams and leadership.

Furthermore, research has linked cross-project learning to multiple domains, showing its relevance across safety, quality, and cost estimation (Achterkamp et al., 2024). Hybrid approaches, combining formal structures with informal exchanges and data analytics, are nowadays considered essential (Wiewiora, 2023).

Critiques of Cross-Project Learning Approaches

- **Lessons learned reviews:** Often archived without integration into future projects (Newell, 2004; Paver & Duffield, 2019).
- **Knowledge repositories:** Risk of under-utilization and neglecting tacit knowledge (Bush & Tiwana, 2005).
- **Data-driven learning:** Challenges in data quality and contextual adaptation (Cai & Zhu, 2015).
- **PMOs:** May be perceived as bureaucratic and disconnected from project realities (Pemsel & Wiewiora, 2013).
- **Communities of practice:** Struggle with long-term engagement and structured impact (Probst & Borzillo, 2008).
- **Staff rotation:** Can disrupt productivity and reduce specialized knowledge retention (Casad, 2012).

While these approaches offer valuable pathways for cross-project learning, their effectiveness depends on several enabling conditions. First, active leadership support and psychological safety are essential to encourage open reflection and critical feedback. Second, knowledge-sharing must be integrated into formal routines—such as planning sessions or estimations—instead of being treated as a standalone exercise. Third, digital tools and repositories must be user-friendly and embedded in everyday workflows to overcome resistance and ensure uptake. Finally, aligning incentives—so that sharing knowledge is rewarded rather than penalized—can help shift learning from an individual responsibility to a collective practice. Without these conditions, even well-designed learning strategies risk becoming symbolic rather than substantive.

3.7. Barriers and Drivers for Cross-Project Learning

As discussed in the previous section on cross-project learning theory, leveraging knowledge from previous projects can significantly improve cost estimation accuracy for future road infrastructure projects. Prior projects provide valuable cost data and lessons that, if shared, help prevent repetitive mistakes and reduce estimation bias (Eken et al., 2020; Hartmann & Dorée, 2015). However, translating this theoretical potential into practice is challenging. Organizations often struggle to learn across project boundaries, facing numerous barriers that hinder the transfer of cost-related knowledge from one project to the next (Ahiaga-Dagbui & Smith, 2014; Flyvbjerg, 2006). Thus, identifying and addressing these barriers while leveraging enablers can bridge theory and practice more effectively.

Barriers to Cross-Project Learning in Cost Estimation

Project Uniqueness and Temporality: Infrastructure projects are often unique and temporary, which creates discontinuities that hinder knowledge transfer (Hartmann & Dorée, 2015). Teams disband quickly, and time constraints prevent post-project reflection, leading to repeated mistakes (Eken et al., 2020). The uniqueness of each project also introduces uncertainty about cost deviations, making lessons harder to generalize (Flyvbjerg, 2006).

Lack of Formal Knowledge Capture Mechanisms: Many firms lack processes for systematically documenting and storing project insights (Ahiaga-Dagbui & Smith, 2014). Without structured repositories, valuable cost data remains inaccessible or lost (Flyvbjerg, 2006). Fragmentation of data in sectors like Dutch road construction compounds the issue (Eken et al., 2020).

Cultural and Motivational Barriers: A culture that discourages transparency or fails to reward knowledge sharing inhibits learning. Teams under pressure may prioritize delivery over documentation (Ahiaga-Dagbui & Smith, 2014). In competitive settings, the fear of admitting estimation errors reduces openness (Eken et al., 2020; Flyvbjerg, 2006).

Lack of Management Focus on Learning: Management often prioritizes short-term project delivery over long-term learning. Hartmann and Dorée (Hartmann & Dorée, 2015) observe that time pressures and operational focus lead to deprioritization of knowledge transfer. Without explicit managerial support, practices like sharing cost estimation insights are neglected, impeding cross-project learning.

Enablers of Cross-Project Learning in Cost Estimation

Standardization and Comparability: Using consistent cost breakdowns and frameworks makes lessons transferable and data more usable (Flyvbjerg, 2006; Hartmann & Dorée, 2015).

Formal Learning Mechanisms and Tools: Project reviews, centralized databases, and knowledge-sharing workshops foster structured learning (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020).

Supportive Organizational Culture and Incentives: Leadership must promote learning values and reward transparency. Cross-project forums and team rotation help break silos (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020).

Enhancing Absorptive Capacity: Training and mentoring help teams apply historical data. Knowledge brokers can support translation of tacit insights (Hartmann & Dorée, 2015).

The link between the barriers and enablers can be seen in 3.10

Table of Barriers and Enablers

Barrier	Enabler
Project uniqueness and temporality	Standardization and comparability through consistent frameworks and cost structures (Flyvbjerg, 2006; Hartmann & Dorée, 2015)
Lack of formal knowledge capture	Implement institutionalized reviews and centralized repositories (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020)
Cultural and motivational barriers	Promote a culture of learning with incentives and open forums (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020)
Knowledge accessibility and quality	Invest in user-friendly systems and training to improve data usability (Hartmann & Dorée, 2015)

Table 3.10: Barriers and enablers of cross-project learning in cost estimation

Practical Recommendations

1. **Standardize cost estimation practices:** Adopt common data formats and frameworks for ease of comparison (Flyvbjerg, 2006).
2. **Develop a formal lessons-learned program:** Require estimating teams to compare estimated vs. actual costs and document lessons in a shared repository (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020).
3. **Promote a learning culture:** Establish roundtables and reward systems to encourage sharing (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020).
4. **Enhance absorptive capacity:** Train estimators and use mentoring to translate lessons into practice (Hartmann & Dorée, 2015).

3.8. Summary of Findings and Knowledge Gap

Key Findings

This chapter answered research question 1 (RQ1). The literature review reveals that cost overruns are a persistent issue in large infrastructure projects globally and in the Netherlands. Empirical studies show that Dutch road projects go over budget by roughly 18% on average, which is somewhat lower than international averages yet still significant. Researchers have categorized causes of cost overruns into technical factors (e.g., scope changes, design errors), economic factors (inflation or market changes), psychological biases, and political-strategic causes. Notably, optimism bias (overly optimistic cost forecasts) and strategic misrepresentation (intentional underestimation of costs) emerge as dominant explanations.

Theoretical Contributions

Several theoretical frameworks have been applied to understand and mitigate these issues. Agency theory has been used to explain political causes, viewing cost underestimation as a result of misaligned incentives between project planners and decision-makers. Behavioral economic insights, such as Kahneman and Tversky's work on optimism bias, emphasize methods like Reference Class Forecasting (RCF). RCF improves cost estimation by using data from past projects to adjust for bias, explicitly aiming to remove optimism bias and strategic misrepresentation from forecasts.

In the realm of project learning, organizational learning theories (e.g., single-loop vs. double-loop learning) and social learning concepts have been introduced. For instance, Hartmann and Dorée (2015) argue that the prevalent "sender–receiver" model of lesson transfer (e.g., post-project reports) treats knowledge as a transferable commodity and has inherent limitations. Instead, they highlight learning as a social, context-dependent process occurring within and across project teams. These contributions have enriched the theoretical understanding of cost estimation and knowledge transfer.

Remaining Knowledge Gaps

Despite these insights, a clear gap remains between theory and practice, particularly in knowledge transfer in cost estimation. The literature indicates that while tools for capturing "lessons learned" exist, project-based organizations struggle to actually reuse knowledge in new projects. In Dutch road infrastructure projects, knowledge gained is often not systematically transferred to subsequent projects.

The reviewed studies address what causes cost overruns and why (theoretically), but offer less on how to ensure that future projects internalize these lessons. This gap is clear in the limited improvement in forecast accuracy and repeated mistakes across projects. In practice, organizational and cultural barriers, such as the temporary nature of project teams and a lack of incentive for learning, impede effective knowledge transfer. Consequently, there is a disconnect between the academic frameworks that advocate cross-project learning and the on-the-ground reality where such learning is minimal. This gap in applying theory to practice forms the focus for further inquiry.

This study contributes to theory by showing that formal mechanisms like evaluation templates and knowledge brokers have limited impact without cultural support and authority. It highlights how informal, mid-project learning can be more influential than post-project reviews—an area underexplored in the literature. These insights nuance existing models by emphasizing that effective learning depends not only on tools, but on how they are embedded in practice.

4
Results

This chapter presents the findings of both the quantitative and qualitative part of this study. Their results reveal a clear tension between the willingness of professionals to learn from previous projects and the organizational reality, preventing them from doing so. Across the interviews and data analyses, it becomes evident that, while learning is valued in principle, it is rarely embedded in daily practice. This is largely due to time pressure, resource constraints, and a lack of institutional mechanisms. This disconnect emerges not only in how project teams reflect (or fail to reflect) on outcomes, but also in the underlying quality and usability of cost data itself.

To explore this phenomenon, the chapter is structured in four parts. Section 4.1 presents the results of a quantitative analysis of cost estimation accuracy, highlighting systematic deviations — despite repeated experience with similar project types. These deviations, and the inconsistencies in data recording practices, illustrate the limitations of learning from previous projects in current estimation processes, thoroughly discussed in Section 4.2. Then, Section 4.3 delves into qualitative findings from the 23 semi-structured interviews, offering insight into how professionals perceive and experience barriers to learning, and what strategies they believe could improve the process. Lastly, in Section 4.4, the qualitative perspective on the quantitative results is discussed.

4.1. Quantitative Results

This section presents the results of a quantitative analysis conducted on selected projects from the local branch of the graduation company. For the selected projects, financial data were collected, primarily on office and technical staff (UTA: Uitvoerend, Technisch en Administratief). UTA-costs were chosen because they are part of every project and provide a consistent basis for comparison. Since these costs are indirect, they are harder to estimate accurately, making them useful for identifying structural problems in planning and cost control. This section explores several key relationships in cost estimation and project characteristics: the accuracy of staff estimations in relation to initial budgets, the impact of contract size and additional work (variation orders) on staff budget deviations, and the implications of these findings for project estimation practices. The goal was to identify whether learning from previous projects is evident in improved estimation accuracy over time — or whether systematic deviations persist, potentially indicating a lack of reflective practice. Results are visualized and discussed through correlation analyses and boxplots, highlighting trends and observations that offer insight into improving estimation accuracy and budget control in future projects. The blue dots represent individual projects. The dotted line indicates the line of the best fit. The methodology for the analysis is described in Section 2.6.

Extra Work vs Staff Cost Deviation

The first relationship examined is between the percentage of extra work (i.e., variation orders) relative to the original contract value and the percentage deviation in staff costs. The result is visualized in Figure 4.1.

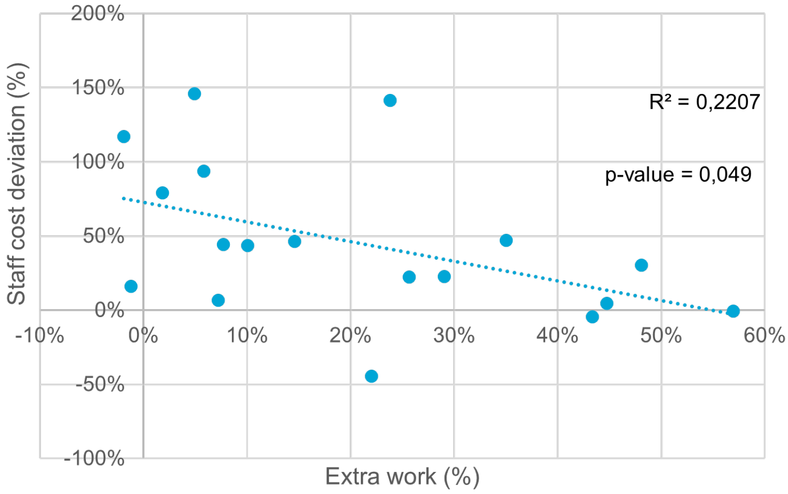

Figure 4.1: Percentage extra work on the contract sum vs staff cost deviation. The blue dots represent individual projects. The dotted line indicates the line of the best fit.

The regression analysis yields an R^2 value of 0.2207 and a p-value of 0.049. The negative trendline suggests that an increase in extra work is modestly associated with a reduction in staff cost deviation. While the R^2 does not meet the 0.3 threshold for strong explanatory power, the p-value below 0.05 indicates the result is statistically significant.

Staff Cost Percentage after tender vs Staff Cost Deviation (Corrected)

This analysis examines the relationship between estimated staff costs as a percentage of the contract sum and the actual staff cost deviation, corrected for variation orders, visualized in Figure 4.2.

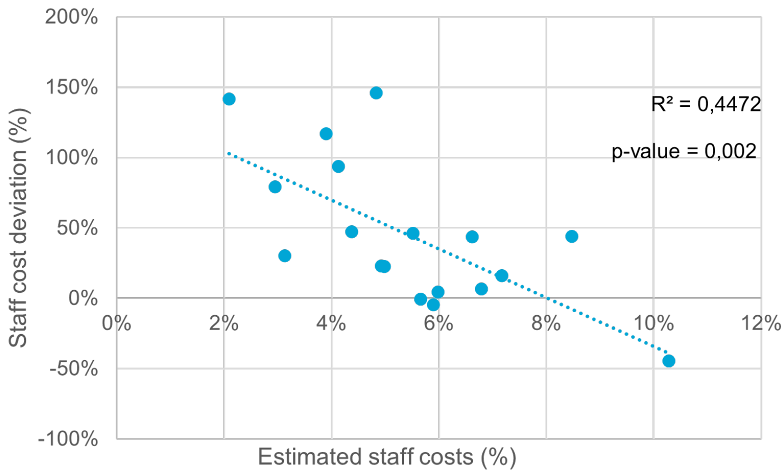

Figure 4.2: Percentage staff cost on the contract sum vs staff cost deviation. The blue dots represent individual projects. The dotted line indicates the line of the best fit.

The regression analysis returns an R^2 value of 0.4472 and a p-value of 0.002. These results are both statistically significant and indicative of a relatively strong correlation. The negative slope suggests that projects with higher initial staff cost percentages tend to have smaller deviations, pointing to more realistic and careful estimations in those cases. This insight may support the idea that underestimating staff needs often results in larger deviations, while higher budgeted staff allocations lead to better budget adherence.

Boxplot: Staff Budget Deviation (Corrected)

To further illustrate the distribution of staff budget deviations (corrected for extra work), a boxplot was created as shown in Figure 4.3.

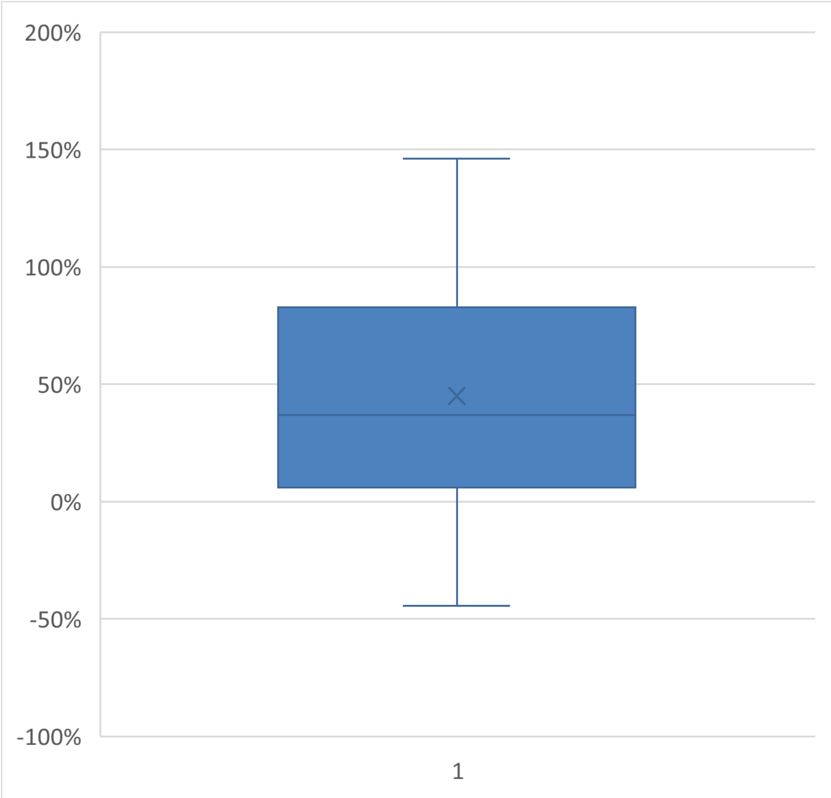

Figure 4.3: Boxplot of the deviation in staff costs from estimated, corrected for extra work.

This boxplot confirms a wide variation in outcomes. On average, the corrected deviation is +45%, indicating frequent underestimation of staff costs. Of the 18 projects, only three did not exceed their anticipated staff costs. Consequently, 83% of the projects incurred higher staffing expenses than expected.

Other Tested Correlations

Additional analyses were performed to test other potential correlations within the dataset. These included relationships between total project value, client type, and staffing deviation, among others. However, these analyses yielded p-values higher than 0.05 and R^2 values below 0.3, indicating weak or statistically insignificant correlations. For transparency and completeness, the full set of these regression results is presented in Appendix A.

Interpretation and Implications

The strongest insight lies in the broader importance of accurate and consistent project cost booking. Variability in the registration of staff costs can arise from inconsistent classifications, incomplete hour logging, or changes in project scope. These issues significantly affect the reliability of cross-project comparisons. The contractor has substantial experience with this contract type and with estimating staff costs, yet the trend across projects is telling: the results still point to a systemic gap in learning. This contradiction, where experienced estimators still produce inconsistent results, underscores that, without high-quality input data, learning remains largely aspirational. These insights are further discussed in Section 4.4.

4.2. Discussion quantitative results: Data without Reflection

While the quantitative results reveal clear patterns in staff cost estimation deviations, they also highlight a deeper issue: the inability to meaningfully interpret those patterns due to inconsistencies and gaps in data recording. This section discusses how technical and contextual limitations in the dataset reflect broader organizational challenges that hinder learning from previous projects, not because of unwillingness, but because of time pressure, fragmented responsibilities, and a lack of systematization. In essence, the data mirrors the central contradiction of this study: even when there is a desire to learn, the conditions to do so are not in place.

Lack of Clarity in Cost Allocation

A critical limitation is the lack of differentiation between staff costs arising from the original contract scope and those incurred due to variation orders. This ambiguity reduces the explanatory power of statistical analysis and complicates the interpretation of the underlying reason for the overrun. Additionally, staff hours are recorded at the project level without attribution to specific phases or sub-tasks, limiting time-phased analysis and obscuring insights into when and why deviations occur during the project lifecycle.

Data Classification and Quality Issues

Not all staff-related expenditures are consistently categorized. Costs such as travel expenses, equipment rental, or line painting by surveyors are sometimes misclassified or insufficiently described. Although efforts were made to correct this, misreporting could only be corrected in cases with clear documentation. These data quality issues reduce analytical depth and weaken cross-project comparability.

Contractual and External Contexts

Additional complexity arises from the diversity in contractual and financial contexts. External factors such as weather conditions, material availability or interactions with local stakeholders and clients could have played a role in staff productivity and cost control, although these factors were not systematically taken into account.

Barriers to learning from previous projects

The lack of clarity surrounding the origin of staff cost deviations highlights a key barrier to learning from previous projects. If deviations cannot be reliably traced back to specific causes, then it becomes difficult for organizations to draw actionable lessons and improve estimation practices. In essence, learning cannot occur effectively without visibility into what is going wrong, why it is going wrong and how wrong the estimation actually is.

Recommendations for Data Improvement

To support better project learning and future research, improvements in data collection and classification are necessary. This includes consistent tagging of cost items, clearer linkage between staff hours and project phases or variation orders, and the integration of contextual metadata such as weather or stakeholder disruptions. Establishing such standards would not only enhance the validity of internal evaluations, but also provide a stronger foundation for data-driven decision-making and continuous improvement across projects.

4.3. Qualitative Results

This chapter presents the qualitative results derived from the 23 semi-structured interviews conducted with professionals involved in the Dutch road infrastructure construction industry. These interviews were designed to explore the underlying factors that influence cross-project learning and its impact on cost estimation accuracy. The interview protocol can be found in Appendix B.

Whereas the quantitative analysis revealed patterns in staff budget deviations, and their correlations with planning and project parameters, this chapter identifies a contradiction: learning from previous projects is widely valued, yet rarely realized in a structured way. Interviewees frequently expressed an eagerness to improve cost estimation practices, but also described how time pressure, lack of ownership, and siloed operations make cross-project learning difficult in practice.

To explore this contradiction, findings are grouped into three interrelated themes based on the research questions:

- Current practices and culture around learning
- Structural barriers that prevent learning
- Strategies proposed to enable learning under pressure

To ensure a comprehensive and representative dataset, participants were purposefully selected from diverse roles across project, tendering, controlling functions, and management. Table 4.1 provides a detailed overview of the interview participants, including their roles, years of experience, and the duration of each interview.

Table 4.1: Overview of the Interview Participants

Participant	Role	Experience in Role	Date	Duration
1	Cost-estimator	38 years	7-4-2025	1h 20 min
2	Cost-estimator	5 years	7-4-2025	1h
3	Cost-estimator	3 years	9-4-2025	55 min
4	Cost-estimator	30 years	10-4-2025	40 min
5	Tender Manager	4 years	14-4-2025	50 min
6	Tender Manager	5 years	14-4-2025	1h 15 min
7	Project Manager	24 years	15-4-2025	50 min
8	Project controller	3 years	16-4-2025	1h 20 min
9	Project Manager	2 years	16-4-2025	45 min
10	Operations Manager	2 years	22-4-2025	50 min
11	Business Controller	4 years	22-4-2025	1h 20 min
12	Operations Manager	2 years	25-4-2025	55 min
13	Project Manager	15 years	25-4-2025	55 min
14	Operations Manager	1 year	28-4-2025	1h
15	Project Manager	2 years	28-4-2025	1h 20 min
16	Project Manager	1 year	30-4-2025	1h 10 min
17	Head of Contract Management	1 year	1-5-2025	1h 10 min
18	Site Manager	25 years	6-5-2025	30 min
19	Operations Manager	17 years	6-5-2025	1h
20	Site Manager	9 years	8-5-2025	45 min
21	Head of Project Office	8 years	12-5-2025	1h 40 min
22	Site Manager	10 years	12-5-2025	45 min
23	Managing Director	1 month	20-5-2025	45 min

Figure 2.2 offers a visual representation of the different roles of the interviewees, highlighting the diversity of perspectives captured during the qualitative phase. The inclusion of project managers, estimators, operations and site managers, as well as financial and contract management roles, provides a robust basis for analyzing cross-functional challenges and learning opportunities.

The remainder of this section is structured thematically. Each section synthesizes findings around a specific topic, supported by direct quotes and recurring patterns identified during analysis. This approach ensures both depth and relevance in assessing how Dutch infrastructure contractors can better learn from previous projects to improve future cost estimation performance.

4.3.1. A Learning Culture: Informal Practices and Positive Intentions

While formal learning mechanisms are limited, many professionals express a genuine interest in sharing knowledge. Within teams, learning happens organically through peer conversations, informal mentorship, and weekly meetings. This reflects a learning-oriented mindset, but one that relies heavily on individual initiative. The interviews highlighted that, despite the absence of consistent evaluation procedures, there is a strong collective belief in the value of reflection and improvement. This section describes the cultural habits, tools, and informal mechanisms that currently shape cross-project learning practices.

Shared Belief in the Importance of Reflection

Interviewees consistently acknowledged the importance of structured reflection for improving cost estimation accuracy. While most could recall only a few formal evaluations, the need for such learning moments was widely endorsed.

> *"If I count my years in execution, it's been about ten years. In that time, I've experienced just one formal project evaluation. That's it."* (Interview 15)

Nevertheless, several participants emphasized that informal, mid-project feedback is often more relevant and actionable than formal end-of-project reviews. These spontaneous interactions allow lessons to be directly applied in ongoing tenders. For example, one estimator (Interview 2) described how he adjusted trench productivity figures in a new bid after discussing actual site performance with a site manager. This form of real-time learning, although effective, often remains undocumented. The same interviewee (Interview 2) acknowledged that such moments of reflection typically stay confined to individual projects, lacking a structured mechanism for wider organizational learning. Other participants expressed a similar concern. One (Interview 15) noted that failing to regularly engage with colleagues in other branches or sister companies was a missed opportunity, suggesting a clear need for more systematic exchange across units.

Informal Open Learning Culture Within Teams

A notable theme across the interviews was the presence of an open, approachable, and collaborative team culture. Many professionals described a flat organizational structure in which knowledge sharing happens freely and without hierarchy. One cost estimator (Interview 1) explained that within the cost-estimation team, people feel equal and are comfortable approaching colleagues directly to ask questions and exchange insights. Weekly cost estimation team meetings were described as important spaces for peer learning, where colleagues often share past experiences and suggest alternative approaches to current estimation challenges.

Importantly, this openness extends beyond day-to-day collaboration. Cost estimators described an atmosphere of psychological safety, which is critical for honest learning. As one cost estimator put it:

> *"Openness ensures that people stay honest. If that openness wasn't there, people would stop speaking up. But because it is, and people expect it, things stay healthy. If someone doesn't behave collegially, it gets noticed."* (Interview 1)

This no-blame culture supports transparency and builds the trust needed to acknowledge and learn from mistakes. Learning is also encouraged across functions. Interviewee 2 noted that cost estimators are supported in reaching out to site managers and project staff to validate or refine their assumptions, especially when similar types of work have been previously executed.

Estimating Tools and Infrastructure

Several structured tools facilitate learning from past projects, with the most prominent being the *moederbegroting* — a centralized cost library containing standardized items based on previous projects. While this system is technically formalized, its maintenance and use are highly dependent on individual initiative.

> *"We use a 'moederbegroting' — basically a big database of experience. Almost every common cost item is in there. If something's missing, we add it."* (Interview 19)

Interviewees noted that the cost library is regularly updated based on new quotes and estimator feedback, often carried out informally by those using it. This practice reinforces a self-driven learning culture in which estimators actively contribute to maintaining knowledge systems. Quality assurance is further supported through a basic four-eyes principle, whereby estimates are reviewed by a second colleague before submission, ensuring internal consistency even in the absence of formal review protocols.

Informal Knowledge Sharing Mechanisms

Beyond formal tools, informal routines play a crucial role in supporting knowledge sharing. Operational managers frequently guide team members toward colleagues who possess relevant experience with similar challenges, helping to sustain awareness of previously evaluated topics (Interview 14).

Cost assumptions are also openly debated in key decision-making moments, such as final tender pricing meetings. As one participant noted:

> *"You can say whatever you think — especially in the final tender pricing meeting. Everyone listens seriously, and we have open discussions."* (Interview 5)

This informal, people-based system enables teams to remain adaptive, even in the absence of fully standardized procedures. Over time, estimators become familiar with each other's expertise areas—such as environmental calculations—and naturally seek out colleagues with relevant knowledge when needed (Interview 2).

QHSE and evaluations

The following insights emerged from a conversation with the Head of QHSE. A responsibility of the QHSE department is to annually compile the outcomes of project evaluations and identify relevant trends. Additionally, QHSE monitors whether all projects exceeding €700,000 are evaluated in compliance with company standards. The department has expressed a preference for conducting more interim evaluations. Currently, QHSE observes approximately five to seven evaluations per year, whereas around twenty projects annually would require evaluations. The department also lacks a clear overview of the exact number of projects that should undergo evaluation each year. Moreover, QHSE staff do not participate directly in these evaluations.

A newly introduced evaluation document has lowered the barrier for conducting evaluations. This document is intended to serve as the agenda during the evaluation meeting and to record the conclusions and discussion points. Because it is shorter and easier to use, it encourages more frequent evaluation sessions. However, concerns have been raised that its conciseness may lead to less thorough reporting, potentially overlooking important details that were previously captured in more comprehensive formats.

Turnover Targets Drive Behavior

The graduation company operates under revenue targets set by the main holding. The local branch also has its own turnover target. Projects carry a percentage of overhead costs (Algemene Kosten or AK), which include expenses such as office space, lighting, etc. These additional costs are covered under the condition that there was sufficient project turnover. Furthermore, the regional director is evaluated against these targets. Similarly, regional business managers each oversee their own area and strive for high turnover, as their performance is also judged accordingly.

This dynamic between evaluation requirements and revenue targets illustrates how organizational incentives can both support and constrain the ability to foster continuous improvement.

All the first instances and second-order themes can be found in Table 4.2.

Overview of Instances About Culture & Practices

Table 4.2: Aggregate Dimension: Culture & Practices

#	1st Order Instances	2nd Order Themes
1	Formal project evaluations are crucial to learn and optimize but happen too rarely	Shared belief in importance of evaluation
2	Learning from projects is essential to avoid falling behind	
3	The company is supposed to be a learning organization	
4	Open, honest environment; cost-estimators walk freely into each other's offices to ask questions	Informal open learning culture
5	Cost estimators are encouraged to talk to the site managers	
6	Mid-project feedback provides more concrete lessons than only post-project reviews	
7	Flat organization; everybody is approachable	
8	No-blame culture within the departments: mistakes are admitted and discussed rather than hidden	
9	Project managers actively discuss recurring issues in meetings	Structural learning
10	Weekly cost-estimation meetings to share experiences and advice	
11	Central standard cost library used for the cost-estimation process (pre-filled cost items as starting point)	Estimating tools and infrastructure
12	Library continuously updated with new contract prices and estimator feedback	
13	Library is updated and this is communicated back to the execution team	
14	Introduction of project control sheet is positive	Financial control initiatives
15	Every estimate checked by an experienced colleague (four-eyes principle)	Informal sharing
16	Personal matchmaking by operation managers to share know-how	
17	Team debates and aligns on contested assumptions (e.g. production rates) in final tender pricing meeting	
18	Cost-estimators regularly consult peers with relevant prior project experience for advice	

4.3.2. Barriers for Learning from Past Projects

Although the previous section revealed a strong willingness among professionals to reflect and learn from project experience, this ambition is frequently undermined by systemic and cultural barriers within the company. Across the interviews, participants described a recurring disconnect between the desire to improve and the organizational realities that restrict the space, time, and structure needed to do so. These barriers are not rooted in disinterest but in an environment where learning competes, and often loses, against the daily demands of project delivery.

Time and Resource Constraints Further Limited by Turnover Targets

The most frequently cited barrier to learning from previous projects was time. Project teams operate under significant pressure to meet deadlines, manage logistics, and respond to real-time execution challenges. In this high-paced environment, post-project evaluations are often perceived as secondary or non-essential. One estimator (Interview 2) explained that field staff often express skepticism about the utility or feasibility of evaluations, viewing them as an additional burden rather than a core project task.

This prioritization becomes even more pronounced when new tender opportunities arise. Supporting upcoming tenders is typically favored over reflecting on completed work, even when such reflections could directly improve future estimates. As one project manager put it:

> *"If I have to choose between supporting a new tender or properly preparing and conducting an evaluation, I would choose the first."* (Interview 7)

A further structural constraint is the persistent shortage of key support roles, such as project controllers. According to one interviewee (Interview 8), the scarcity of qualified staff in this function means that existing employees are stretched thin, limiting their ability to support evaluation processes. The broader skilled workforce shortage in the Dutch construction sector (Centraal Bureau voor de Statistiek, 2025) exacerbates this issue. For example, one respondent (Interview 23) noted that their company was operating with approximately eight vacant site manager positions at the time of the interview, increasing the workload for existing staff.

Although executing fewer projects could theoretically relieve the pressure and create space for learning, commercial demands and turnover targets constrain such decisions. As one operational manager (Interview 23) remarked, downsizing project volume is not always feasible due to top-down financial expectations for branch performance.

Cultural Resistance and Negative Perceptions

In addition to time pressure, learning is hindered by cultural perceptions that frame evaluation as a blame exercise rather than a tool for improvement. This mindset creates reluctance to engage in open reflection. One participant (Interview 14) noted that evaluations are frequently treated as formalities, often stored away without follow-up or visibility. As a result, there is little organizational awareness of which evaluations have been completed or what their outcomes were.

Others expressed concern that evaluations risk becoming judgmental, leading to interpersonal friction instead of constructive dialogue. This association limits the psychological safety needed for open and honest conversations about what went wrong and why. One participant observed:

> *"You only end up with hassle about what did or didn't go well. And who did a good job and who didn't."* (Interview 6)

Lack of Formal Structures and Ownership

A further barrier lies in the absence of formal mechanisms and clear ownership for learning. Many interviewees described learning as an ad hoc activity with no dedicated coordinator or process. As one cost estimator summarized when asked who is responsible for learning:

> *"Actually, no one explicitly. Everyone a little. And that's tricky, because then it's no one's real responsibility."* (Interview 1)

Even when evaluations are conducted, their outcomes are rarely documented in a consistent manner. One participant (Interview 12) pointed out that while the head of the project office holds valuable knowledge, much of it remains in his own possession or in individual memory. Without structured documentation and feedback loops, lessons fail to travel beyond individual teams or projects.

Fragmented Collaboration Between Roles

Several interviewees pointed out that cross-role collaboration — especially between cost estimators and execution teams — is limited or inconsistent. Some estimators maintain strong ties to the field, while others rarely visit construction sites:

> *”There are also estimators who’ve never been out on site.”* (Interview 7)

This creates a disconnect between those who plan and those who execute, limiting opportunities for mutual learning. A similar disconnect exists with project controllers. One participant (Interview 8) noted that these roles have become increasingly absent from evaluation processes in recent years. These organizational silos limit the depth of feedback and hinder the learning that could emerge from collaboratively interpreting project outcomes.

Neglect of Financial Learning

Surprisingly, financial performance receives limited attention during evaluations. The financials are often only superficially discussed:

> *”Often the financial part is only discussed at the end, in the last five minutes, and all other matters have already been covered.”* (Interview 8)

This superficial treatment of cost performance raises questions about financial awareness among project managers. As one participant (Interview 19) wondered, while some site managers are well-informed about their financial standing, others appear more focused on managing daily operational tasks and may lack a clear view of their project’s budget status.

Project-Specificity and Lack of Standardization

Many respondents pointed to the unique character of each project as a reason why lessons are not easily transferred. This belief, while often valid in technical terms, becomes a justification for ignoring repeatable patterns:

> *”The situation is often so specific that it’s difficult to standardize the lessons for use in other projects.”* (Interview 14)

This perceived uniqueness reduces the incentive to codify or share knowledge, reinforcing a project-by-project mindset.

Organizational Silos and Distrust

The decentralized structure of the contractor contributes to organizational silos, which limit learning between regions. One interviewee (Interview 3) remarked that regional teams often have little idea of what their colleagues elsewhere in the country are doing, resulting in fragmented knowledge sharing. In addition to this isolation, some respondents noted subtle forms of inter-unit competition and historical mistrust. For example, one site manager observed that some colleagues still ”keep their cards close to their chest,” reflecting habits from a time when branches competed more directly (Interview 5).

> *“There’s a kind of mistrust between units.”* (Interview 18)

Such dynamics hinder collaboration and prevent the development of a collective learning culture across the wider organization.

All the first instances and second-order themes can be found in Tables 4.3 & 4.4.

Table 4.3: Overview of Instances about Barriers (Part 1)

#	1st Order Instances	2nd Order Themes
19	Execution teams are too busy with projects to do after-completion evaluations	Time and resource pressure hinders learning
20	Feeling of low priority from top management	
21	Hard to learn from cost data if not coded specifically	
22	New projects or tenders are perceived as more important than old projects	
23	Execution unable to participate in tender phase (e.g. site visits) due to lack of capacity	
24	Evaluation meetings get repeatedly postponed by urgent project issues	
25	Staff shortages	
26	Traditional culture leads to little perceived need to change	Cultural resistance
27	Experienced project managers see little learning opportunity	
28	No explicit role responsible for capturing lessons	Lack of formal learning structure
29	Key tender/estimating knowledge is tacit (in people's heads) instead of documented	
30	Project evaluations not shared	
31	Feeling that points of improvement are not picked up	
32	Knowledge isn't systematically shared across projects or departments	
33	Evaluations can turn into two camps fighting each other	Negative association with evaluations
34	Evaluations are seen as a burden	
35	Fear of negative judgment (sharing risk)	
36	Evaluations primarily focused on negative aspects	
37	Project evaluations (when done) are often seen superficial "checkbox" exercises	
38	Cost-estimators without field experience stay desk-bound, hesitant to engage with execution teams	Limited estimator-execution collaboration
39	Cost-estimation teams at the office not always work together with the execution team	
40	Lack of feedback loop from execution to estimating for too high estimates	
41	Estimators sometimes hesitate to visit projects due to fear of receiving mainly negative feedback	
42	Project controllers are frequently left out of post-project evaluations	Neglect of financial learning
43	Evaluations during execution phase are seen as not useful for the execution team	
44	Not all site managers monitor project finances	
45	Uncontrolled cost bookings by support departments reduce site manager's financial control	
46	Reliance on gut feeling over tender data leads to missed opportunities in execution	
47	Financial aspects get only brief attention in evaluations	
48	Evaluation reports feel too abstract to outsiders	Projects are unique
49	Context-specific nature limits cross-project learning	

Table 4.4: Overview of Instances about Barriers (Part 2)

#	1st Order Instances	2nd Order Themes
50	Employees must build their own informal network to share knowledge	Organizational silos
51	Selective sharing of lessons	
52	Execution team's mistakes rarely addressed in evaluations (focus is on calculation and external factors)	
53	Minor mistakes or quick fixes often go unshared	
54	Each branch has its own estimating approach; minimal sharing or standardization across branches	
55	Experiential learning sticks, paper knowledge transfer is problematic	
56	Regional conditions differ (soil, etc.), limiting the applicability of another region's lessons	
57	EMVI-measures not tracked or feedback lacking	
58	Lessons learned are not shared between branches	
59	Physical distance and unfamiliarity raise the threshold for office–execution contact	
60	Historical silo mentality between regional units	
61	Distrust between units limits collaboration and knowledge exchange	
62	Semi-competitive mindset between sister offices	

4.3.3. Strategies to Enable Learning from Past Projects Under Pressure

The interviews revealed that, while structural and cultural barriers inhibit cross-project learning, professionals are not short on ideas for how to overcome them. Across roles and regions, respondents demonstrated a clear willingness to improve learning practices and offered pragmatic strategies for embedding learning into the project cycle. What unites these proposals is their focus on making learning easier and more natural, rather than heavier or more bureaucratic. In other words, the challenge is not a lack of motivation, but the need for learning to fit within the operational reality of project work.

Creating the Conditions to Make Learning Possible

Beyond specific tools or processes, several interviewees emphasized that learning requires an enabling environment. Without structural time, team continuity, and visible leadership support, even strong intentions to reflect and improve will not materialize. One recurring suggestion was to create deliberate overcapacity in project teams, offering a buffer that enables professionals to step back and reflect. For instance, one interviewee (Interview 22) explained that teams are often so structurally overloaded that mistakes occur simply due to a lack of time. Providing more space for individual and collective evaluation could, in their view, substantially accelerate learning.

Participants also stressed that leadership must visibly endorse learning — not just in principle but through daily routines and operational priorities. One proposed strategy was to assign a project administrator to large projects, thereby relieving site managers of some administrative burden and freeing up mental space for reflection (Interview 23). This point was clearly articulated by the managing director, who emphasized the symbolic and practical role of leadership in prioritizing learning:

> *"Management should emphasize and support the importance of learning…..Encourage that through the operations manager. If the organization shows that it values this, it really helps."* (Interview 23)

These reflections underscore that learning depends not only on individual behavior but also on how roles, expectations, and workflows are designed and resourced across the organization.

Embedding Evaluation Early and Lightly

A frequently mentioned strategy was to reinstate project evaluations as a routine and structured activity, not as an administrative add-on, but as an integral part of project delivery. Several interviewees called for evaluations to be planned in advance — ideally at the moment a project is awarded — to avoid being sidelined by other priorities later on. As one estimator put it:

> *"You should really plan it right when the project is awarded — even if it's set for a year later. Add it to the calendar so it doesn't get forgotten."* (Interview 1)

There was broad agreement that evaluations had lost their central position in recent years, with one project manager remarking that they had really fallen by the wayside and needed to be re-emphasized (Interview 4). Some participants suggested including dedicated financial reflection moments as part of the evaluation process, particularly to benefit cost estimators. Several also stressed the importance of storing evaluation insights in a central, accessible location. One interviewee suggested that although evaluations are carried out, there is much room for improvement in how findings are shared, and that having a centralized database for lessons learned would be a valuable step forward (Interview 12).

These reflections underline that institutionalizing evaluation means making it routine and low-threshold by embedding it early in the project lifecycle and supporting it with accessible tools for storage and reuse.

Simplifying Data for Learning

While formal evaluations remain important, many professionals emphasized the value of simple, data-informed reflection. One branch manager argued that the current cost-booking system is too detailed and that what really matters is tracking high-level production figures, such as tons of asphalt per day (Interview 19).

Rather than measuring everything, interviewees advocated for selecting a few key performance indicators (KPIs) that could be tracked and discussed across projects:

> *"Don't try to measure everything... pick the most important things that drive progress. That should be decided during the kick-off or handover."* (Interview 19)

Others proposed a more consistent use of post-calculation analysis to systematically compare planned and actual costs (Interview 1). A Post-calculation (or *nacalculatie*) is a retrospective cost□analysis performed once a project is finished. It involves comparing the original budget or estimate with the actual costs incurred. These approaches emphasize efficiency: learning needs just the right level of reflection at the right time.

Strengthen Execution–Estimator Interaction

A major theme across interviews was the need to bridge the gap between cost estimators and execution teams. Many interviewees emphasized that informal conversations, not necessarily formal meetings, are often the most effective way for knowledge transfer.

> *"It's already incredibly useful when a cost estimator just spends a morning in the site cabin. It feels much more natural than a formal evaluation with a form. These conversations should just happen organically."* (Interview 2)

Despite this, such interactions remain the exception rather than the rule. Several participants noted that time constraints are a persistent obstacle, even though brief visits or check-ins could already add value (Interview 2). Others pointed to emerging practices, such as project controllers conducting site visits to gather financial insights. One interviewee (Interview 18) expressed hope that these insights would be routinely shared with cost estimators.

To further reduce the disconnect between cost estimation and execution, some interviewees proposed a more regionalized structure. Assigning cost estimators to fixed regional teams could help speed up communication and promote stronger working relationships.

> *"Pair estimators with regional teams… it shortens the lines."* (Interview 23)

This approach was also suggested as a way to accelerate onboarding and build organizational cohesion, for instance by rotating new employees through fixed regional teams (Interview 23). These reflections underscore that learning is not a detached activity but deeply embedded in the relational dynamics of daily project work.

Cross-Branch Learning Initiatives

Several interviewees expressed a clear desire to move beyond project-specific learning and enhance knowledge exchange between regional branches. While informal contacts already exist, many advocated for more structured cross-branch platforms — such as quarterly knowledge-sharing sessions — to facilitate the transfer of lessons learned across locations (Interview 3).

Some also emphasized the need for top-down encouragement to institutionalize such initiatives without making them feel compulsory. For example, one operations manager (Interview 12) suggested that team leaders should help create space for reflection when valuable experiences arise, keeping the process meaningful rather than bureaucratic.

There was also interest in standardizing cost estimation practices across the organization. One estimator (Interview 1) recommended developing a shared template with national coordination to improve consistency and mutual learning across branches.

The management team, in particular, sees a role for itself in stimulating this broader learning culture:

> *"Maybe that's something for us as operation managers — to initiate and support. If we see something worth discussing, we should encourage teams to reflect and learn from it. It shouldn't feel like a chore, but we should stimulate it."* (Interview 12)

These perspectives reflect a growing recognition that learning from past projects should be supported not only within the branch, but also across other branches.

All the first instances and second-order themes can be found in Table 4.5.

Table 4.5: Overview of Instances about Strategies

#	1st Order Instances	2nd Order Themes
63	Make project evaluations (again) a standard required step	Institutionalize evaluation
64	Schedule/post-plan evaluations at project outset so they aren't forgotten	
65	Evaluations should cover key points: forecast vs outcome, safety, collaboration, and any design aspect	
66	Need for a central lessons-learned database	
67	Holding dedicated financial evaluation sessions	
68	Hold project evaluations mid-project (for long-lasting projects) to capture ongoing lessons	
69	Large evaluation meetings with too many participants are inefficient	
70	Need for informal interim project evaluations	
71	Both the execution team and the project office should prepare the evaluation to ensure efficiency	
72	Project leaders are responsible for conducting evaluations and share lessons with estimating team	
73	Logging interim lessons in the Project Control Sheet for later evaluations	
74	Ensure there is real follow-up on evaluation outcomes, in a culture of learning rather than blaming	
75	Potential benefit from top-down initiative for knowledge sharing	
76	QHSE produces quarterly reports of evaluation trends, which are presented and shared in the branch's meetings	
77	Embed lessons learned at the project kick-off	
78	Proper cost coding is a prerequisite for meaningful evaluations	
79	Management should emphasize and support the importance of learning, even if it costs time and money	Create overcapacity

Continued on next page

Table 4.5 Continued from previous page

#	1st Order Instances	2nd Order Themes
80	Adding project administrators so site managers have less administration tasks	
81	Deliberate staffing “overcapacity” on projects is needed to enable learning and reflection	
82	Excessively detailed cost tracking obscures lessons – better to focus on high-level production metrics	Data-driven learning improvement
83	Selecting a few key performance metrics at project start (instead of measuring everything) enables focused learning	
84	Site manager should be the only one that can book costs on a project	
85	QHSE coordinator should gather the evaluations and look for trends across all departments	
86	Do detailed post-calculation of actual vs estimated costs to find patterns (data-driven learning)	
87	Closer estimator–execution interaction (site visits, interim evals) to transfer field knowledge	Strengthen execution-estimator interaction
88	Close estimator–executer collaboration occurs in small private client projects but is lacking in large tenders	
89	Mandatory transfer meeting between cost estimators and execution team	
90	Include the cost estimator in evaluations to compare estimates with actual outcomes	
91	Office employees can learn from outside	
92	Project controller acts as a link by gathering on-site data and feeding financial insights back to the office	Strengthen cooperation within branch
93	Assign estimators to specific regions and project teams to strengthen their connection with execution	
94	Integrate new employees faster by having them take part in a fixed regional team	
95	Organize more site managers meetings at the office	
96	Quarterly cross-branch forums for estimators to exchange lessons learned	Cross-branch learning initiatives
97	Seeking knowledge from other branches or sister companies	
98	Increase standardization and one-company mindset (coordinate practices nationally)	

4.4. Qualitative Perspective on the Quantitative Results

This section offers a qualitative interpretation of the patterns found in the quantitative analysis, drawing on 23 semi-structured interviews with professionals involved in estimating, executing, and controlling infrastructure projects. The interviews helped contextualize the 45% average deviation in staff cost estimations by revealing the procedural, behavioral, and structural realities behind those numbers. A consistent theme emerges: although professionals are motivated to learn from past experiences and improve their estimates, they are constrained by structural limitations and competing priorities.

Experience-Based Estimating Under Pressure

Staff hour estimations are largely experience-based and often finalized under pressure, typically during the final tender pricing meeting, without systematic use of historical data. Several interviewees reported that while initial calculations may be realistic, totals are frequently revised downward to align with broader project budget constraints.

> *"You add up all the staff hours, then everyone gets scared by the total, and the number gets cut."* (Interview 9)

Estimates are frequently adjusted downwards to meet overall budget constraints, despite internal awareness that the reduced values may be unrealistic. While general guidelines suggest staff costs should fall between 5–10% of total project costs, these are not enforced as hard rules. Additionally, certain recurring tasks, such as revisions, digital surveying, or post-delivery documentation, are not always structurally included in the initial estimate.

Gaps Between Budget and Reality

Interviewees confirmed that a 45% overrun in staff costs is consistent with their experience, but stressed that deviations are highly context-dependent. Factors such as project type, team composition, and unforeseen execution challenges influence outcomes significantly. This variability makes it difficult to apply standard ratios or key figures across different projects.

Cost Booking and Administration

Administrative inconsistency was a recurring concern. Multiple interviewees observed that when several team members book costs on the project, the financial administration becomes fragmented and less accurate. Interviewees highlighted that ideally, only the site manager should control project bookings, as multiple bookers often lead to chaos (Interview 13). When hours must be booked but a clear allocation is missing, they may be arbitrarily assigned, further distorting cost records (Interview 15). Misclassifications of staff-related items, such as transportation, rented equipment, or road striping, compound these administrative inaccuracies.

Human Behavior and Team Dynamics

Human factors strongly influence staff costs booking. Staff deployment is often based on personal preferences, individual routines, and perceived competencies. Interviewees pointed out that site managers differ widely in their efficiency and digital proficiency, both of which impact actual staff hours. There is also a reluctance to register idle or "leegloop" hours, due to fear of reputation damage or internal critique.

> *"People don't want to book on 'leegloop' because it looks bad, even if it's justified…People should feel safe booking hours on 'leegloop' — but they don't."* (Interview 15)

Stable project teams tend to work more efficiently and accumulate learning benefits over time. Some project managers deliberately keep team members onboard longer than necessary to preserve continuity, trading short-term costs for long-term efficiency gains (Interview 20).

Structural Causes of Overruns

Several structural factors that contribute to budget deviations were identified. These include dual staffing situations, where junior employees are mentored by more experienced staff without this duplication being included in the budget.

> *"I had to mentor a new site manager — so we both ended up booked on the project full-time."* (Interview 13)

Furthermore, the distinction between contract work and extra work is often unclear in time registration systems. External cost escalators—such as wage increases linked to new collective labor agreements—also play a role, yet are not systematically incorporated into initial planning. Note that this would only account for a few percent of the cost overruns.

Risk and Awareness

Execution teams often lack visibility into budgeted versus actual staff hours, weakening their ability to manage resource allocation effectively. Some interviewees noted that awareness of staff budgets must be clearer from the outset (Interview 2).

While the practice of shifting hours between projects is rare, interviewees acknowledged the temptation, especially when certain projects underperform.

> *"If you're on a (financially) bad project and a good one, and you put your hours on the good one, nobody complains."* (Interview 15)

Poor registration practices interfere with the performance metrics of individual projects and hinder organizational learning. Many operational decisions are still made based on experience, with little feedback from actual data.

Suggestions for Improvement

Interviewees recommended actionable strategies to enhance estimation accuracy. First, past data should be used systematically to define key metrics, leveraging historical project data to inform future estimates (Interview 9). Second, simplifying booking systems with standardized, limited cost categories was suggested to improve clarity and ease analysis (Interview 8). Third, the use of continuously updated staff planning through tools like the Project Control Sheet was highlighted as beneficial, allowing early detection of deviations (Interview 11).

Interviewees also recommended closer collaboration between project controllers and execution teams to detect and respond to deviations early. Lastly, encouraging team continuity across projects was identified as a means to leverage learning curves and reduce inefficiencies, but this was sometimes contradicted by other participants.

5
Discussion

This chapter connects the findings from the literature review and the results from Chapter 4 using a multi-level learning framework. The chapter focuses on the barriers in systematic reflection identified in Section 4.3.2 and examines why learning often fails to translate into practice.

A key insight from the interviews is the persistent mismatch between the desire to learn and the capacity to act on it. Staff widely recognize the importance of evaluation, yet learning activities are regularly sidelined due to operational demands. This highlights the knowing–doing gap, where the intention to improve is blocked by organizational pressures that favor short-term delivery over reflection.

Projects produce valuable insights, yet each new one often starts without drawing on past experience. Even when formal evaluation procedures are in place, they are rarely enforced or supported with time and resources. Without dedicated time for reflection, learning remains informal, undocumented, and hard to apply across teams or future projects.

5.1. Framework: Projects as Temporary Organizations

This section introduces the theoretical lens underpinning the analysis: a framework that conceptualizes projects as temporary organizations embedded within a broader coordinating entity. Drawing on foundational work by Lundin and Söderholm (1995) and Packendorff (1995), this perspective highlights the structural tensions that arise when learning must persist across the short-lived boundaries of individual projects. Each project functions as a temporary organization: it operates with a high degree of autonomy, assembles its own team, delivers within a specific contractual scope, and disbands once completed. According to Lundin and Söderholm (1995), such organizations are characterized by being time-bound, task-oriented, team-based, and transitional in nature. Packendorff (1995) further conceptualizes projects as processes of temporary organizing, where short-term execution goals often conflict with long-term learning needs. This creates systemic barriers to capturing, sharing, and embedding knowledge across project boundaries. The framework helps explain not just where learning occurs, but how it is transferred—or fails to be transferred— throughout the organization over time.

From 4I to 6I: Foundations of the Learning Framework

The framework builds on the progression of organizational learning models developed by several researchers (Crossan et al., 1999; Jenkin, 2013; Wodnik et al., 2024). Crossan's original 4I model (Figure 3.2) defines four learning processes, Intuiting, Interpreting, Integrating, and Institutionalizing, that describe how learning flows between the individual, group, and organizational levels. These processes are referred to as social psychological because they operate at the interface between individual cognition and collective understanding: individuals form insights (intuition), make sense of them (interpreting), share and align meanings with others (integrating), and embed them into routines (institutionalizing). Jenkin (2013) extends this model with a fifth process, Information Foraging as can be seen in (Figure 3.3). This concept highlights how individuals actively search for and evaluate data as a prerequisite to learning, especially in environments where information is abundant but fragmented. Separately, Wodnik et al. (2024) also built directly on the original 4I framework and introduced two additional processes: Interaction and Incorporation (Figure 3.4). These concepts capture the flow of knowledge across different communities and organizations, reflecting how ideas are shared and institutionalized in complex ecosystems. The frameworks are further explained in Section 3.5.

The Coordinating Body: The Construction Firm

In this framework, the construction company acts as the coordinating body overseeing multiple projects. It is responsible for:

- Defining the overarching learning strategy and procedures
- Maintaining and curating knowledge repositories (e.g., the *moederbegroting*)
- Incentivizing learning activities
- Institutionalizing cross-project learning structures
- Supporting learning-focused roles such as QHSE departments, or PMOs

While projects are the primary sites of activity and learning, the coordinating body plays a critical role in maintaining organizational memory and enabling continuous improvement in cost estimation over time.

Visualizing Learning Flows: Introducing the 7th I

The framework is visually presented in Figure 5.1, adapted from Wodnik et al. (2024), and integrates insights from the 4I, 5I, and 6I models. It maps both forward learning flows (from individual intuition to group interpretation and project application) and feedback loops (such as evaluation and institutionalization).

The arrows represent informal, social-psychological learning pathways, including peer exchanges and intuitive judgment. Crucially, the framework highlights a common break in learning continuity at the project level: after project completion, teams disband, and valuable insights often fail to reach the coordinating body or future projects. This observation directly aligns with the patterns identified in the Gioia structure under ”Limited Institutionalization” and ”Temporality as a Barrier” Section 4.3.1 & 4.3.2).

To better reflect what happens during project execution, a seventh “I” is introduced: **Iterating**. Iterating captures real-time learning that unfolds through mid-project reflection, informal communication, and shifts in team composition. As new members join or rotate into the team, they bring fresh perspectives that trigger re-evaluation of assumptions and decisions. These dynamics enable continuous adaptation throughout project execution. While previous models emphasize learning across levels, such as from individual to group to organization.

In the case of the graduation company, findings suggest that good intentions alone are not enough to support effective learning across projects. Interview data from Section 4.3.1 repeatedly emphasized the knowing–doing gap: while staff value learning, they lack time, resources, and structural support to act on evaluations. This supports the broader argument that in project-based organizations, intentional organizational structures are needed to retain and transfer knowledge beyond individual projects.

Propositions

To clarify the theoretical contributions, a series of propositions is presented that extend the core multi□level learning model. Each proposition specifies a presumed mechanism between levels (individual, group, project, or coordinating body). All propositions are grounded in the patterns that emerged from the interview coding and Gioia analysis, as summarized in Section 4.3.3. The framework is visible in Figure 5.1):

- **P1: Group → Project, “Integration”** Knowledge developed within functional groups, such as the cost estimation team, enhances project assumptions and planning when it is incorporated into new tenders and execution strategies.
- **P2: Project → Group, “Institutionalization”** Lessons learned during project execution contribute to strengthened collective practices when they are routinely shared at the group level, for example, through project manager meetings.

- **P3: Project → Coordinating Body, "Incorporation"** Insights from structured mid- and post-project evaluations support continuous learning and policy refinement when they are systematically transferred to the organizational level.
- **P4: Coordinating Body → Project, "Institutionalization"** Centralized tools and guidelines, informed by previous learning, lead to more consistent application of best practices when they are embedded into new projects and tenders.
- **P5: Group → Coordinating Body, "Incorporation"** Insights from recurring group-level activities, such as weekly cost estimation meetings, influence the development and refinement of standardized tools and procedures.
- **P6: Coordinating Body → Group, "Institutionalization"** Synthesized lessons, data, and tools distributed by the coordinating body enable more informed decision-making at the group level when shared through structured formats like estimation meetings.
- **P7: Within the Project, "Iterating"** Mid-project reflection and informal communication lead to continuous adaptation during project execution.

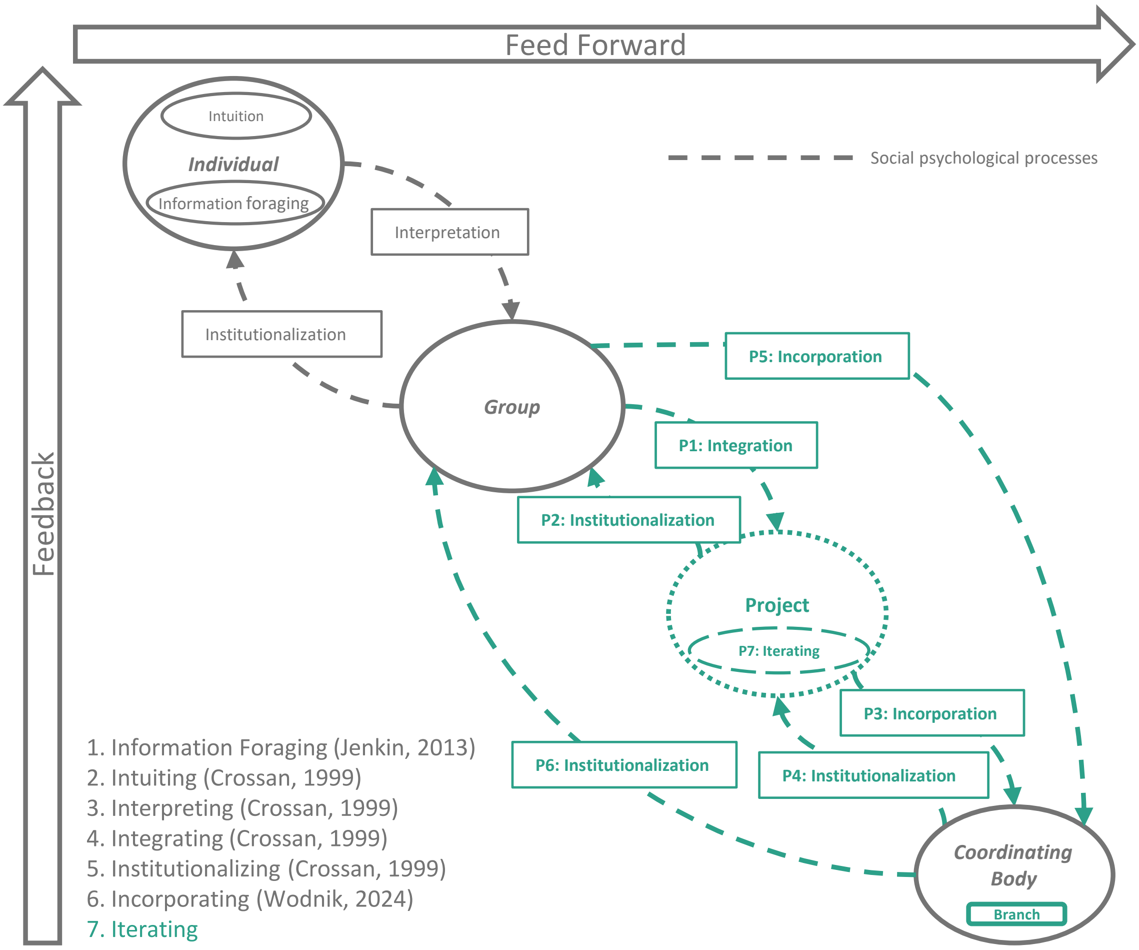

Figure 5.1: Learning across temporary projects and coordinating structures. Framework in gray is adapted from Crossan (1999), Jenkin (2013), Wodkin (2024). New contributions are in green. Propositions P1–P7 indicate new processes explored in this discussion.

5.2. Integrating Literature and Findings Using the Framework

In this section, the findings from the literature and the interviews are described in the context of the framework.

5.2.1. Individual Level – Information Foraging, Intuition, Institutionalization, and Interpretation

At the individual level, employees recognize the importance of learning from past experiences and actively seek insights through informal means. Yet, operational pressures often limit their capacity to reflect or share knowledge in a structured way, reinforcing the knowing–doing gap described by Newell (2004). Despite strong motivation, many lack the time, structure, or support to act on their intentions. Interviewees emphasized that even low-effort practices—such as mid-project check-ins or brief handover summaries—can yield meaningful insights without overburdening teams.

Does Time Enable Learning?

An open question emerging from this study concerns the relationship between time availability and actual learning outcomes. While interviewees frequently identified a lack of time as a key constraint (see Section 4.3.2), it remains unclear whether simply allocating more time would automatically lead to deeper reflection or improved learning outcomes. This raises a critical consideration: does time enable learning, or must it be combined with cultural, procedural, and managerial enablers to become effective? Without structured mechanisms, psychological safety, and accountability, extra time may be absorbed by other priorities or lead to unproductive reflection.

This question calls for further research and experimental piloting, testing whether protected reflection time, coupled with clear framing and facilitation, leads to measurable improvements in estimation accuracy or cross-project knowledge reuse. Unless individuals see how their contributions to learning translate into tangible improvements, they may view reflection as a distraction rather than an investment, especially when working under pressure. This also raises a deeper point: while learning benefits teams and the wider organization, through better estimates, fewer mistakes, and smoother delivery, it offers little immediate return to individual staff. Under deadline pressure, reflection may be seen as a distraction from core responsibilities. This mismatch between who invests effort and who gains results helps explain why learning is so often sidelined.

Identified Barriers:

- Behavioral biases (optimism bias, anchoring) (Flyvbjerg, 2006; Hartmann & Dorée, 2015)
- High time pressure and heavy workloads (Ahiaga-Dagbui & Smith, 2014)
- Lack of dedicated time or incentives to document individual insights

Strategies Proposed:

- Institutionalizing regular periods for structured reflection (Ahiaga-Dagbui & Smith, 2014)
- Training programs aimed at bias recognition and mitigation (Flyvbjerg, 2006)

5.2.2. Group Level – Integration, Institutionalization, and Interpretation

At the group level, informal interactions, such as peer conversations and mentoring, play a crucial role in integrating knowledge. This aligns with the idea of communities of practice described by Wiewiora et al. (2010). Although these interactions facilitate tacit knowledge sharing, formal systems for capturing and embedding this knowledge are often weak or missing.

Interviewees often mentioned a lack of coordination between estimators and execution teams and pointed to blame cultures that reduce psychological safety and limit open reflection. Although tools like templates and formal reviews exist, most learning still occurs informally, through quick conversations, mentoring, or solving daily problems. These informal methods are more flexible, especially when time is limited.

The findings suggest that formal learning systems are often too rigid or underused, while informal approaches are more effective because they match the way people actually work and communicate.

Identified Barriers:

- Poor collaboration between cost estimators and the execution team
- Negative association with evaluations and blame culture
- Over-reliance on experienced individuals to drive learning, leading to inconsistency

Strategies Proposed:

- Establishing regular cross-role workshops and forums (Hartmann & Dorée, 2015)
- Creating evaluation frameworks that avoid blame and promote psychological safety (Flyvbjerg et al., 2002)
- Encouraging peer mentoring between team members
- Appointing learning coordinators to support knowledge exchange

5.2.3. Project Level – Institutionalization, Iterating, Incorporation, and Integration

Although tools like the *moederbegroting* offer institutional support by embedding historical cost data into new tenders, broader learning across projects to update this tool remains inconsistent and depends on the initiative of employees (Ahiaga-Dagbui & Smith, 2014; Flyvbjerg, 2006).

Because of the temporary setup and the lack of mechanisms to retain and share these lessons, insights usually stay within the project where they emerged and are not passed on. A further complication is the disconnect between financial performance and learning practices—projects may meet budget targets without reflecting on the estimation errors or near-misses that occurred, reducing the perceived urgency for post-project learning.

Identified Barriers:

- Projects are often seen as unique, which discourages generalizing lessons (Flyvbjerg, 2006)
- Lack of systematic institutionalization across projects (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020)
- Disconnect between financial performance and learning practices
- Inconsistent use of post-project evaluations

Strategies Proposed:

- Standardizing cost breakdown structures and integrating consistent cross-project evaluation processes (Flyvbjerg, 2006; Hartmann & Dorée, 2015)
- Creating formal roles to safeguard the continuity of learning (Julian, 2008)
- Involving financial controllers in project close-out sessions to connect learning and cost performance
- Requiring a short learning summary as part of the official project handover

5.2.4. Coordinating Body Level – Incorporation, Institutionalization

The coordinating body—whether the regional branch or the central organization—plays a crucial role in embedding learning across projects through incorporation, institutionalization, and strategic direction. It oversees multiple projects, defines learning priorities, and maintains shared knowledge systems (Wodnik et al., 2024).

Although formal tools such as QHSE oversight and central databases are in place, findings show they are poorly used due to fragmented access, low visibility, and unclear incentives. A central challenge at this level is the lack of mechanisms to distinguish between cost estimation errors caused by poor data or bias and those made intentionally for strategic reasons (e.g., to remain competitive). Without formal processes to record and classify these decisions, post-project reviews risk assigning the wrong cause to deviations, which may lead to flawed conclusions and ineffective follow-up actions.

As Crossan et al. (1999) emphasized, long-term learning requires institutionalization. By turning shared understanding into formal systems and routines. Julian (2008) adds that without clearly defined coordination roles, learning across projects tends to remain isolated and inconsistent. This is also the case at the graduation company, where there is no clear, designated role responsible for managing and integrating lessons learned across the organization. Instead, responsibilities are divided between the head of the project office, project managers, and the quarterly QHSE reporting process.

In interviews, operations managers emphasized the importance of reflection and learning and mentioned that they communicate this to project leaders and field staff. However, there is a noticeable gap between what managers believe they are communicating and how teams actually interpret it. If everyday leadership behavior focuses on project turnover, then even verbal support for learning can lose credibility.

To strengthen the organizational learning loop, the coordinating body should adopt a more iterative approach to policy development and evaluation focus. Rather than treating each project as a discrete case, lessons learned from recent evaluations should inform the strategic themes and operational priorities of subsequent learning cycles. For instance, specific cost overrun patterns identified this quarter, such as deviations related to scope change, can shape the next quarter's evaluation focus. Broader themes, such as estimator-execution coordination or cultural barriers to knowledge sharing, may be targeted over a longer annual cycle. This phased approach mirrors safety policy cycles already embedded in many construction firms and ensures that evaluation becomes not only retrospective but also prospective and adaptive.

Identified Barriers:

- Weak incentives and insufficient leadership commitment (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020)
- Fragmentation and poor accessibility of data systems (Hartmann & Dorée, 2015)
- Underutilization of formal tools such as databases and protocols
- Learning oversight roles often lack authority, visibility, and operational influence

Strategies Proposed:

- Defining clear accountability and assigning dedicated roles for knowledge management (Julian, 2008)
- Improving the usability and integration of central knowledge systems (Hartmann & Dorée, 2015)
- Facilitating structured cross-branch and cross-project learning sessions (Ahiaga-Dagbui & Smith, 2014)
- Raising the visibility and authority of QHSE or other departments responsible for learning

5.2.5. Bridging the Temporality – Institutionalizing Learning

One of the main challenges is bridging the "interruption" between project cycles. This interruption undermines organizational memory and prevents the translation of project-level insights into sustainable organizational improvements. As highlighted in Section 4.3, knowledge captured informally within projects is rarely formally institutionalized at the organizational level, aligning with theoretical critiques by Hartmann and Dorée (2015). This underscores the need for stronger coordination mechanisms, as highlighted in Section 4.3.3, and supports calls for dedicated knowledge management roles within the organization.

A key area for improvement is leadership modeling. The management team (MT) must actively show that learning and reflection are as important as short-term goals like winning tenders or hitting revenue targets. Because reflection doesn't deliver quick results—while financial performance is reviewed monthly—learning often becomes a low priority. Without visible, ongoing support from the MT, learning is easily overlooked.

Strategies Proposed:

- Enforcing structured post-project reviews and capturing insights systematically (Ahiaga-Dagbui & Smith, 2014; Eken et al., 2020)
- Integrating insights into pre-project planning and organizational standards (Flyvbjerg, 2006)
- Reinforcing the role of QHSE and Project Offices in overseeing continuous learning (Julian, 2008)
- Scheduling kick-off meetings that include lessons learned from previous projects

One of the most actionable findings concerns the role of visible leadership. While strategic support from top management is essential, the presence of everyday leadership practices within projects both from members of the MT and the project managers, such as scheduling mid-project reviews, facilitating open dialogue, or reflecting on deviations, is what enables learning to become embedded in routine. Project managers act as translators between organizational intent and on-the-ground behavior. They link formal systems to practical decisions, and their actions determine whether learning flows upward to the organization or remains siloed.

Therefore, bridging the temporal nature of projects is not just a structural challenge but also a behavioral one. It requires that learning is not only scheduled or recorded, but also modeled and reinforced by those in direct leadership positions. By positioning the project at the center of cross-level learning, and by emphasizing the importance of leadership within those projects, the framework helps clarify where interventions must occur to institutionalize learning over time.

Learning must become part of the regular workflow, not an extra task. This means reducing the effort required to participate, visibly supporting reflection through leadership, and showing how individual contributions feed into broader improvements. By doing so, the organization can move toward a culture that values avoiding repeated mistakes as much as delivering quickly.

Overall, the multi-level analysis helps answer the research questions of this study. Insights explain how professionals view and apply learning (RQ2), while the analysis of project and organizational factors highlights deeper barriers to institutionalized learning (RQ3). The proposed strategies offer a concrete path forward to overcome these issues and improve learning across projects (RQ4).

6 Conclusion

This study explored how learning from previous projects can be improved to make cost estimation more accurate in the Dutch road construction industry. It investigated both the evolution of cost estimation processes and the experiences of practitioners within the graduation company, a leading Dutch contractor. The research focused on routine activities during the tendering phase, analyzing whether and how reflection is integrated into daily estimating work. By analyzing both quantitative deviations in cost estimates and qualitative insights from interviews with professionals, the research aimed to provide more understanding of how organizational learning processes shape cost estimating accuracy.

The main objective of this research was to answer the main research question:

"How can learning from previous projects be strengthened to improve cost estimation accuracy of Dutch road construction projects?"

This central question was addressed by answering four research questions.

6.1. Research questions

6.1.1. RQ1: What is the current body of knowledge on learning from previous projects and cost estimation in the construction industry?

Existing literature indicates that inaccurate cost estimates and cost overruns are persistent problems in the construction industry, suggesting a failure to sufficiently learn from previous projects (Cantarelli, Molin, et al., 2012; Flyvbjerg, 2021; P. E. D. Love et al., 2015). Researchers such as Flyvbjerg argue that these inaccuracies are often systemic, driven by cognitive and political pressures such as optimism bias and strategic misrepresentation, rather than simple forecasting errors (Flyvbjerg, 2006).

Numerous studies have documented frequent cost overruns, for instance, Dutch road projects average approximately 18% over budget, and have explored why cost overruns occur (Cantarelli, Van Wee, et al., 2012; Molinari et al., 2023). However, the literature provides less insight into how organizations internalize lessons from these failures to improve future estimates. Although formal tools like post-project reviews and knowledge databases exist, their impact is often limited in real-world practice. Because construction organizations are largely project-based, with temporary and fragmented teams, transferring knowledge is difficult to organize and maintain over time (Debs & Hubbard, 2023).

This gap between theory and practice is evidenced by the continued recurrence of cost overruns and limited improvements in estimation accuracy over time. Organizational constraints, such as the lack of incentives and enduring project isolation, hinder effective knowledge reuse (Hartmann & Dorée, 2015). In summary, the academic body of knowledge emphasizes the potential of learning from previous projects to improve cost estimation. Nonetheless, institutionalized learning in tender-phase cost estimation remains underdeveloped. This highlights the need for practical strategies that can close the gap between knowing and doing, and help make reflective learning a regular part of cost estimating routines.

6.1.2. RQ2: What is the employee perception on learning from previous projects with the goal of improving the accuracy of cost estimation?

The interviews conducted in this study reveal a strong awareness among professionals of the value of learning from previous projects. Cost estimators and project managers consistently emphasized their intent to reflect on past outcomes to avoid recurring mistakes. This shows a natural awareness of behavioral economics concepts like optimism bias and anchoring (Flyvbjerg, 2006).

Despite this awareness, actual learning practices remain limited. Interviewees cited time pressure, workload, and the immediate demands of tendering as primary constraints. Post-project evaluations are often omitted or conducted superficially. Feedback on project performance rarely reaches the estimators, leading to a disconnect between estimate and outcome. As a result, even well-intentioned professionals struggle to adjust their future estimates using real data from past projects (Hartmann & Dorée, 2015).

Competitive pressure makes this even harder. The need to keep bids low discourages estimators from using historical data that might raise expected costs. In the end, while many employees want to learn, the organization's structure and culture often get in the way, creating a gap between what people say they value and what they are actually able to do.

6.1.3. RQ3: Which barriers hinder the application of learning from previous projects to improve the accuracy of cost estimation in Dutch road construction?

Several barriers hinder the application of learning from past projects. First, strong time pressure and limited staffing make learning a low priority. Tender teams are often under tight deadlines and simply do not have time to reflect on earlier projects or apply those lessons to new ones (Debs & Hubbard, 2023).

Second, there is a lack of formal learning structures. Processes like lessons-learned sessions or feedback loops are not consistently used, and there is little follow-up from management. This means valuable insights are often siloed, undocumented, or lost when team members leave.

Third, the temporary nature of project teams in construction reinforces learning isolation. Once a project ends, the team breaks up, and opportunities to pass on insights disappear. This project-based structure creates ongoing knowledge gaps (Newell, 2004).

Fourth, poor data quality makes it difficult to use past cost information effectively. Inconsistent entries, unclear cost codes, and missing context reduce the value of historical data for new estimates.

Finally, behavioral factors—such as fear of blame or overconfidence—discourage people from openly discussing past mistakes. These combined barriers help explain why certain cost deviations, especially in staff-related costs, keep recurring even in similar types of projects.

6.1.4. RQ4: What are strategies to improve learning from previous projects for cost estimation in the context of Dutch road construction?

This study identified a set of connected strategies to improve learning in cost estimation processes. One of the most important is to make evaluations a standard part of every project. Embedding both post-project reviews and mid-project reflection moments into normal workflows helps ensure that learning becomes routine, not sporadic. These activities need to be scheduled and resourced in project plans to avoid being pushed aside by time pressure. The findings suggest that formal planning and dedicated time are essential for making evaluations effective.

Another key strategy is to strengthen feedback loops between execution and estimation teams. Many interviewees said that estimators rarely receive structured, timely feedback on how accurate their forecasts were. Suggested tools include digital dashboards or summary reports, which could support faster and more direct learning.

A second group of strategies relates to the improvement of knowledge infrastructure. Better historical cost data—both in terms of quality and accessibility, can support more accurate, evidence-based estimates. Using methods like reference class forecasting helps teams draw on patterns from similar past projects (Flyvbjerg, 2006). In addition, mentorship and peer learning activities allow practical, experience-based knowledge to flow between colleagues, especially useful for training junior staff.

Aligning incentives also plays a crucial role. Learning efforts should be acknowledged and rewarded, and performance indicators for managers should reflect not just results but also how well lessons are reused. Interviewees also pointed to leadership behavior and psychological safety as important cultural factors. When leaders set the tone for open reflection and support learning, employees are more likely to trust and engage with learning systems.

6.2. Main Research Question

To answer the main research question, the study first addressed four related research questions based on the research objectives. (1) The literature review (Chapter 3) showed that infrastructure cost estimation is influenced by both technical challenges and behavioral dynamics, yet it frequently lacks structured learning processes. (2) The quantitative analysis (Chapter 4) revealed widespread staff cost deviations, with no consistent signs of improvement over time. (3) The interviews (Chapter 4) highlighted several barriers to learning from previous projects, including limited feedback, time pressure, and poor knowledge systems. (4) Finally, professionals described promising strategies for improving knowledge reuse in estimation—such as routine evaluations, better data access, stronger feedback loops, and cultural incentives. These insights are brought together to answer the main research question:

"How can learning from previous projects be strengthened to improve cost estimation accuracy of Dutch road construction projects?"

This research concludes that improving learning requires making reflective practices a standard part of how the organization works. While estimators are motivated to improve, learning still happens on an ad-hoc basis due to time pressure, missing routines, and a lack of timely feedback. Bridging this gap between intention and action needs clear, structured efforts from the organization.

The findings show that cost deviations, especially in staffing, continue not because teams lack experience, but because that experience is not reused systematically. To enable meaningful learning, teams need dedicated time, accessible knowledge, regular feedback, and a culture that supports continuous improvement.

Therefore, improving cost estimation is not just a technical issue; it is a learning challenge. Organizations must institutionalize lessons learned, support them with simple tools and clear processes, and build trust between estimators and execution teams. Over time, this approach should reduce repeated mistakes and provide more reliable estimates.

This research also extends organizational learning theory by treating the project not just as a site of execution, but as a temporary learning organization in its own right. While most learning models focus on individuals, groups, and permanent organizational structures, this thesis introduces the project as a distinct level within the learning process. By embedding the project level into the framework, the study helps explain why learning often stalls after project completion: teams disband, roles dissolve, and insights remain trapped in temporary structures.

This perspective has implications beyond the Dutch road construction sector. In any project-based environment, whether in engineering, consulting, or IT, the temporary nature of teams creates barriers. Recognizing projects as temporary organizations helps clarify where learning is likely to break down, and which interventions (such as mid-project evaluations, structured handovers, or project-based knowledge leads) can improve continuity.

In conclusion, the thesis finds that the key to improving cost estimation accuracy in Dutch road construction lies in **prioritizing learning**. Learning must be built into the daily routines and valued by the wider organization. Only then can the industry move toward more predictable and effective project delivery.

7

Recommendations and limitations

7.1. Practical Recommendations

Building on the findings in Chapters 3 & Chapter 5, this section recommends the following actions for the graduation company and similar organizations to enhance learning from projects for cost-estimation. The recommendations are structured using the Plan–Do–Check–Act (PDCA) cycle (Taylor et al., 2014) and are shaped and verified through the lens of the multi-level learning framework for project-based organizations. This framework emphasizes how learning processes at the individual, group, project, and organizational levels must be aligned to achieve sustained improvements. The PDCA-based structure integrates this complexity by addressing different decision-making levels (group, project, and coordinating body), defining barriers, and distinguishing between short-term (1 year) subjects, such as improving staff cost data collection, and long-term (3–5 years) themes such as improving overall cost booking accuracy.

Decision matrix for Thematic Learning

To support adaptive implementation, a decision framework is proposed to assess whether annual interventions have achieved meaningful progress on the selected topic. These topics fall within broader themes that span a three- to five-year horizon. Only when a topic shows tangible improvement will the organization move to the next topic within the same overarching theme. Table 7.1 presents a decision logic that the graduation company can use to guide this process.

Condition (if...)	**Decision (then...)**
The interventions in the annual plan were successfully implemented and adopted	Proceed to the next topic within the overarching 3–5-year theme
Only partial implementation or strong team dependency	Prioritize standardization and leadership involvement to support broader adoption
No visible improvement on the selected topic	Extend the annual focus and introduce deeper interventions (e.g., additional support or KPIs)

Table 7.1: Decision matrix for learning within the graduation company

Short-term Focus (0–12 months)

Plan

- **Who:** Project Office, QHSE, Project Managers
- **Barrier:** Evaluations are overlooked due to time pressures.
- **Action:** Schedule mandatory evaluations upfront at project initiation, highlighting their strategic priority.

- **Action:** Choose a focus for the next year and choose criteria for assessing if learning is achieved in the subject.

Do

- **Who:** Execution Teams, Cost Estimators, Financial Controllers
- **Barrier:** Limited cross-role interaction, informal knowledge loss during projects.
- **Action:** Introduce structured mid-project reflection points to capture real-time insights.
- **Action:** Facilitate regular cost-estimator site visits and active involvement of financial controllers in evaluations.
- **Action:** Focus on the chosen subject and capture lessons for the evaluation.

Check

- **Who:** Execution Teams, Head of Project Office, QHSE
- **Barrier:** Negative perception and complexity of evaluations.
- **Action:** Monitor progress on the subject during informal mid-project reflections.

Act

- **Who:** Head of Project Office, Cost-Estimators, Management Team (MT)
- **Barrier:** Weak follow-up on evaluations, inconsistent use of insights.
- **Action:** Establish clear routines for updating centralized data platforms based on evaluations.
- **Action:** Regularly discuss evaluation outcomes in regional meetings, visibly led by senior management.

Long-term Focus (3–5 years)

Plan

- **Who:** Management Team (MT), Head of Project Office, QHSE
- **Barrier:** Fragmented and inconsistent historical data, focus on day-to-day project efforts.
- **Action:** Assign formal responsibility for learning to a specific function(s).
- **Action:** Choose subjects that together form a theme of focus.

Do

- **Who:** Head of Project Office, Cost-Estimators, Execution Teams
- **Barrier:** Persistent cultural and communication gaps between estimating and execution teams.
- **Action:** Institutionalize joint estimator-execution teams and mandatory transfer meetings.
- **Action:** Form a central system for storing lessons learned.

Check

- **Who:** Management Team (MT), Head of Project Office, QHSE
- **Barrier:** Low trust in historical data quality, inconsistent use of knowledge repositories.
- **Action:** Conduct periodic audits of progress on the theme and the subjects.
- **Action:** Introduce systematic “cause tagging” in post-project evaluations to classify deviations as strategic, scope-related, or estimate-related.

Act

- **Who:** Management Team (MT), Head of Project Office, QHSE
- **Barrier:** Lack of strategic integration of learning outcomes into broader policy-making.
- **Action:** Regularly integrate evaluation insights into strategic policy development, making knowledge sharing a standing agenda item at senior meetings.

Balancing Immediate Project Goals and Long-term Learning

Turnover targets are non-negotiable — management cannot avoid them. However, a way must be found to give greater priority to learning and reflection. In the short term, this could negatively affect revenue or project profit, either by taking time away from project staff or by requiring additional personnel. These recommendations aim to make learning routine, not exceptional. And integrating it into project delivery cycles rather than treating it as an optional afterthought.

To achieve this balance, additional actions include:

- Encourage senior management (MT and regional managing directors) to visibly advocate for and follow up on evaluation processes.
- Reward and publicly recognize employee-driven improvement initiatives to reinforce a positive culture around learning.
- Organize occasional inter-regional knowledge exchanges and networking events among project managers to promote broader organizational learning.
- Regularly involve office staff in field activities (e.g., quarterly site visits) to improve practical understanding and collaboration.
- Use pilot projects and highlight small, early successes to gradually reinforce and embed a stronger learning culture.
- Develop mentorship programs that formally recognize and reward experienced staff who actively share their knowledge with junior employees.
- Integrate evaluation outcomes into forward-looking policy design: Ensure that trends and recurring insights from recent evaluations are used not only to update tools but also to define the learning focus for upcoming years. This transforms evaluation from a retrospective formality into a dynamic feedback loop that shapes future practice.

7.2. Theoretical Contributions

This thesis contributes to the literature on organizational learning in project-based environments by offering two primary theoretical insights. These contributions address key limitations in how existing learning theories have been applied to temporary organizations such as infrastructure contractors.

First, the study demonstrates that leadership plays a central role in enabling or constraining organizational learning. While prior research has acknowledged the importance of leadership support in general terms, this study shows in detail how specific leadership behaviors influence the institutionalization of learning. These behaviors include the visible prioritization of learning, consistent allocation of time and resources for learning activities, and the alignment of incentives to support knowledge sharing. The findings suggest that learning systems, such as evaluation routines or cost feedback loops, only become embedded when leaders actively support their use, follow up on outcomes, and communicate their strategic value. This advances current theory by linking organizational learning not only to formal processes, but also to the day-to-day actions and priorities demonstrated by leadership in fast-paced, delivery-focused project environments.

Second, the research highlights the significance of learning that occurs during project execution, rather than solely through formal post-project evaluations. Much of the literature has focused on retrospective learning, particularly through lessons-learned reviews or post-project analyses. However, this study finds that many critical insights emerge while the project is still in progress. These include mid-project adaptations, peer-to-peer exchanges, and informal adjustments to cost assumptions in response to evolving circumstances. Because these insights are rarely documented, they are often lost when the project concludes. This challenges the assumption that learning is primarily a post-project activity and instead points to the need for a broader theoretical perspective that includes in-project learning as a dynamic and continuous process. Enabling this form of learning requires organizational mechanisms that help identify, capture, and share emerging knowledge before the project ends.

Together, these contributions deepen the theoretical understanding of how learning unfolds in project-based organizations. The findings suggest that effective organizational learning depends not only on the availability of tools and procedures, but also on leadership behavior and the timing of reflection. Recognizing and supporting learning during project execution, and embedding it into routine, can strengthen cross-project learning and improve the use of insights in future cost estimations.

7.3. Limitations

The use of semi-structured interviews enabled in-depth exploration of learning behaviors and organizational culture. Including diverse roles; cost estimators, project managers, and controllers, strengthened the reliability of themes through triangulation.

However, limitations exist. Some roles, such as senior leadership, were underrepresented, which may have constrained insights into strategic decision-making. All interviewees came from a single organizational branch, limiting generalizability to other firms or sectors.

The researcher's dual role as an intern may also have influenced responses. While this position facilitated access and rapport, it could have led to social desirability bias, particularly when discussing sensitive topics like blame culture or management performance.

Findings are based on self-reported experiences, which are inherently subjective. While patterns were consistent, future research could benefit from complementary methods such as document analysis or observational studies to validate behavioral claims. In particular, direct observation of evaluation practices or booking behavior could help distinguish between reported intentions and actual routines.

Moreover, while the study focused on cost estimation processes, it did not systematically distinguish between inaccuracies caused by cognitive or organizational learning gaps and those resulting from deliberate strategic pricing decisions. Several interviewees noted that final tender prices are sometimes intentionally lowered to remain competitive, regardless of past project insights. This distinction between learning-related errors and strategic business behavior was outside the analytical scope of this study but may have significant implications for interpreting deviations in estimation accuracy.

The research adopted a multi-level learning framework to interpret findings across individual, group, project, and organizational dimensions. While this lens helped organize the data meaningfully, it may oversimplify the interactions between levels or overlook alternative theoretical perspectives, such as motivational or institutional theories that could further explain why lessons are or are not transferred.

Finally, the research looked at one moment in time and relied on people's memories and opinions about past projects. Due to time constraints and the nature of the thesis process, it was not possible to observe the long-term implementation of proposed interventions or to assess their impact on future estimation practices. As such, the study represents a snapshot of current learning conditions and should be interpreted accordingly.

7.4. Generalizability of Findings

While this study focused on a single branch of a Dutch road construction firm, many of the identified challenges—such as time pressure, blame culture, lack of feedback loops, and fragmented data use—are common across project-based sectors. The emphasis on temporary project teams, cost competitiveness, and decentralized learning structures mirrors conditions found throughout the Dutch infrastructure sector and in similar contracting environments globally. As such, the proposed strategies—like early evaluation planning, learning slack, and empowering coordinating roles—are likely to be relevant beyond this specific firm. However, contextual factors such as contract type (e.g., RAW vs. UAV-GC), organizational maturity, and leadership culture may influence implementation. Further research across diverse companies and sectors would be valuable to assess the broader applicability of these interventions.

7.5. Recommendations for Future Research

Future studies should test interventions, like structured reviews or improved knowledge systems, across multiple projects or firms. Long-term studies could measure how estimation accuracy and learning culture develop over an extended period. Further research into the use of digital tools, leadership styles, and motivators for learning would help clarify how learning can be better integrated into day-to-day project work. Learning during project execution and the use of regular feedback moments, which were frequently mentioned by respondents, are still not well understood and deserve more attention. The possible role of departments like QHSE as facilitators of knowledge sharing also deserves closer study, especially in companies with limited capacity to create dedicated roles. As discussed in Section 4.2, inconsistent cost data makes it harder to learn from project deviations. Future research could examine how better data structuring supports more effective learning from past projects.

Future research could also examine how organizations can tell the difference between cost estimation errors caused by limited learning and those that result from deliberate strategic choices, such as competitive underbidding. Looking into how these decisions are recorded, reviewed, and understood could improve the value of lessons learned and help avoid wrongly blaming the causes of cost deviations in project reviews.

It would also be useful to explore how staffing levels, time pressure, and workload influence an organization's ability to support structured learning. This could help determine whether learning efforts fail because they are poorly designed or simply because employees do not have the time or capacity to take part in them.

A related open question is whether providing employees with more time actually leads to more learning. While time is widely cited as a prerequisite for reflection, future studies should examine whether time alone is sufficient or whether it must be paired with structured formats, psychological safety, and cultural support to generate meaningful learning outcomes. Experimental designs or field studies could compare outcomes across teams given time alone versus time with embedded learning structures.

Another critical research avenue concerns the trade-off between learning and delivery: What is the optimum balance between learning and doing in project environments where time and resources are limited? Empirical studies could assess how shifting this balance affects short-term performance versus long-term capability development.

In addition, future work could explore how to shape or compose project teams in ways that optimize learning. What team compositions, leadership styles, or peer dynamics support high learning capacity? How can organizations intentionally cultivate learning-oriented team cultures while maintaining operational effectiveness?

Small-scale experiments or pilot studies could test what happens when projects assign dedicated learning roles, such as learning coordinators or knowledge stewards. These studies could measure the effects on estimating accuracy, knowledge sharing, and changes in team culture, especially by comparing similar projects with and without these roles.

Studies comparing companies with different cultures, structures, or contract types (for example, public versus private clients) could help explain how the wider context affects learning behavior. This would also show which findings can be applied more broadly and which are specific to certain environments.

Together, these research directions can help close the gap between the desire to reflect and actual learning in practice. By testing ideas in different settings and looking at practical limits like time and role clarity, researchers can offer better ways to help organizations build strong and sustainable learning habits.

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A

Graphs quantitative results

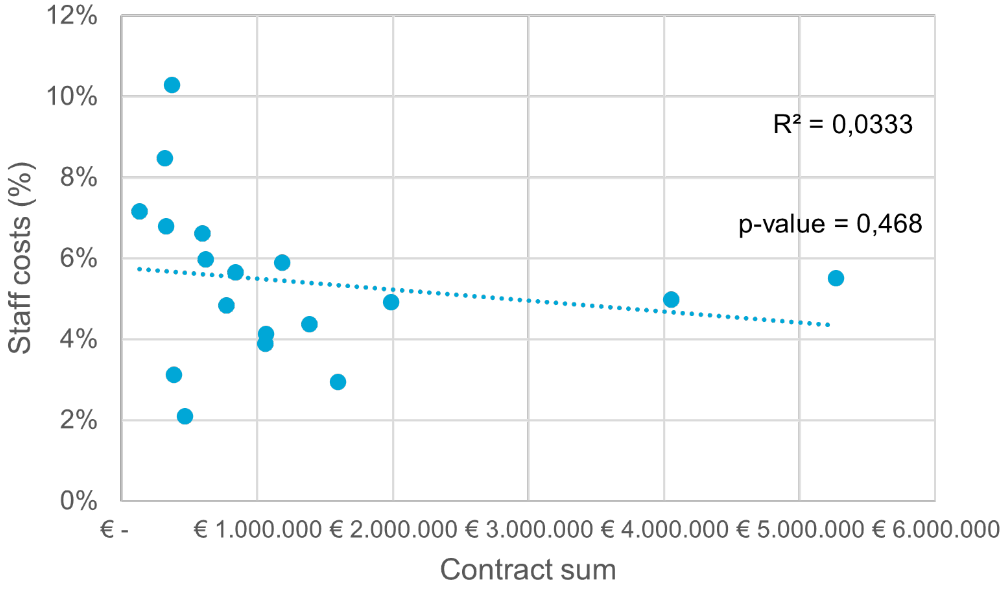

Figure A.1: Contract value after tender phase VS Percentage estimated staff costs. The blue dots represent individual projects. The dotted line indicates the line of the best fit.

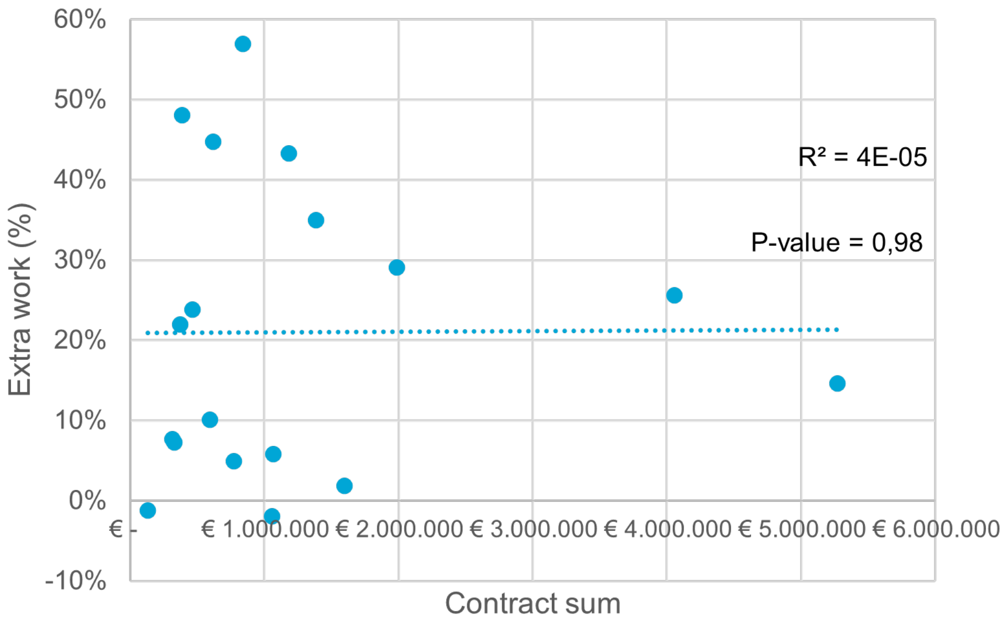

Figure A.2: Contract value after tender phase VS Percentage extra work. The blue dots represent individual projects. The dotted line indicates the line of the best fit.

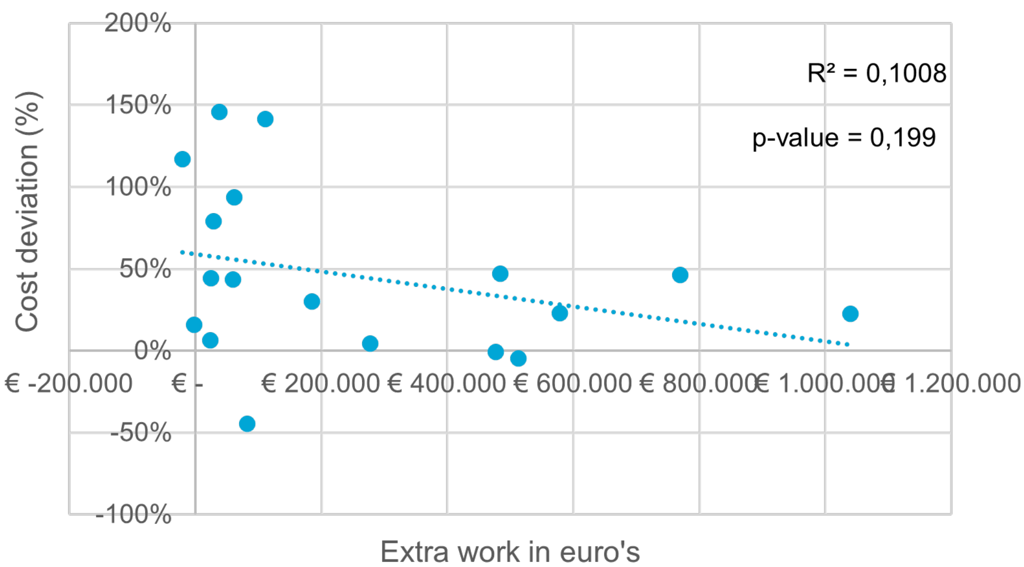

Figure A.3: Extra work VS staff cost deviation (corrected). The blue dots represent individual projects. The dotted line indicates the line of the best fit.

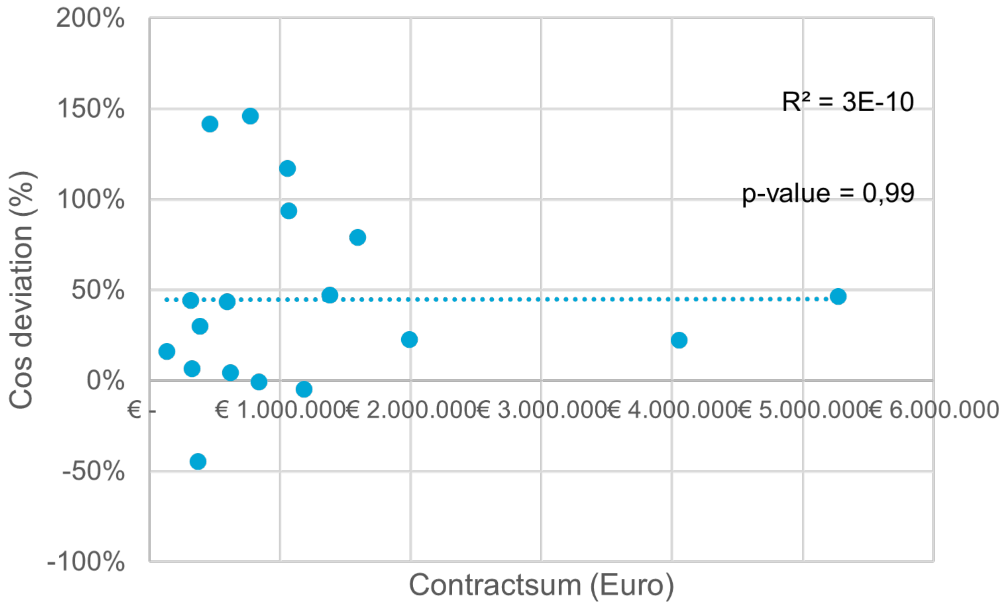

Figure A.4: Contract value after tender phase VS staff cost deviation (corrected). The blue dots represent individual projects. The dotted line indicates the line of the best fit.

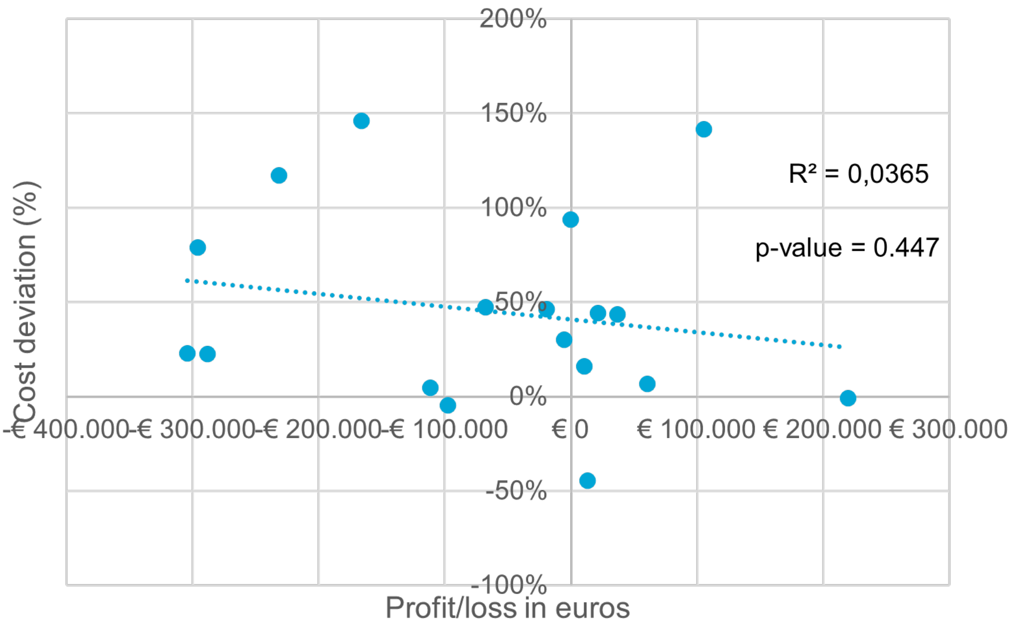

Figure A.5: Financial result on the project VS staff cost deviation (corrected). The blue dots represent individual projects. The dotted line indicates the line of the best fit.

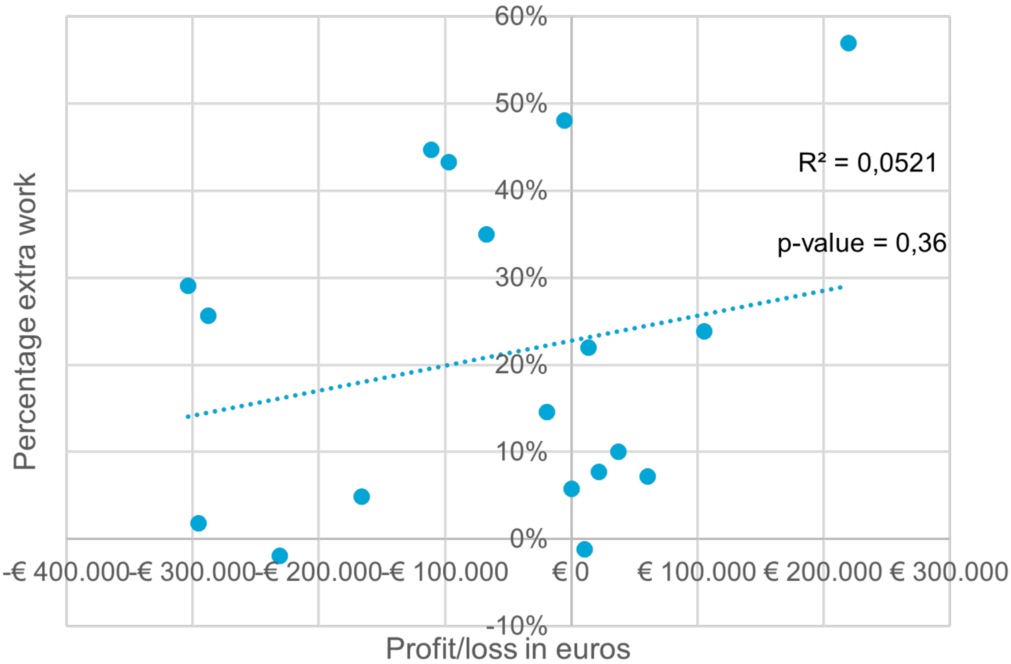

Figure A.6: Financial result on the project VS percentage extra work. The blue dots represent individual projects. The dotted line indicates the line of the best fit.

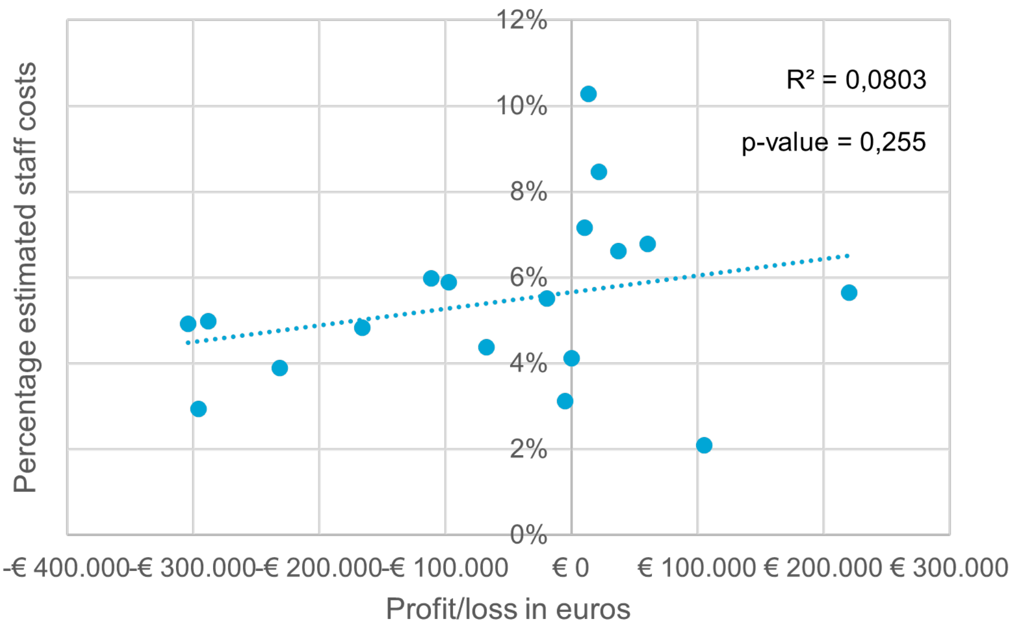

Figure A.7: Financial result on the project VS percentage estimated staff costs. The blue dots represent individual projects. The dotted line indicates the line of the best fit.

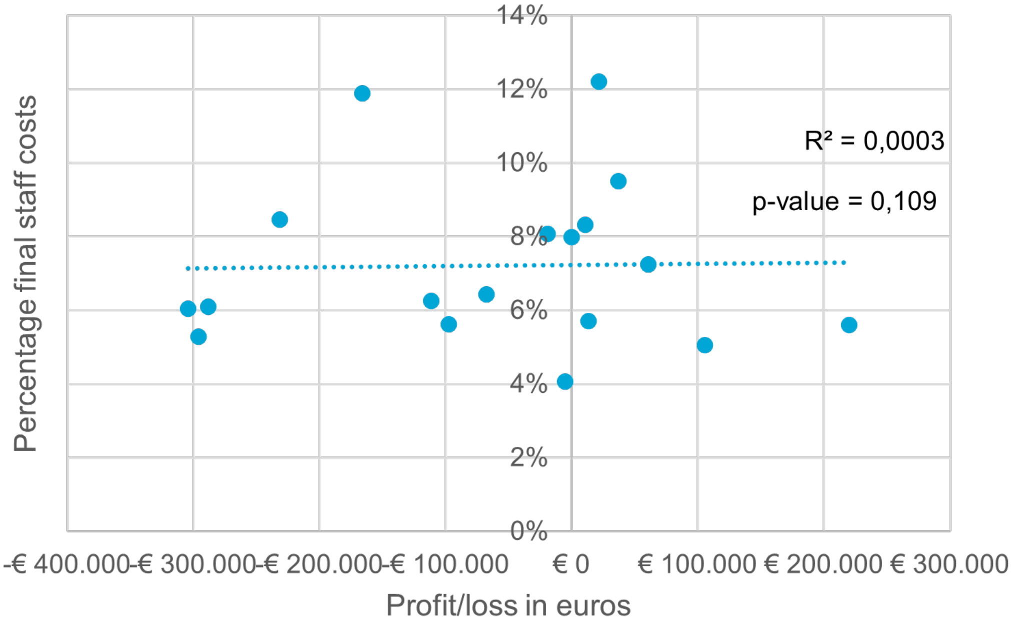

Figure A.8: Financial result on the project VS percentage final staff costs. The blue dots represent individual projects. The dotted line indicates the line of the best fit.

B

Interview protocol

ENGLISH

Introduction: What is your role at the graduation company and how many years' experience do you have in these roles?

Aggregate Dimension 1: Current culture & cross-project Learning practices (SQ2)

1. From your role, could you guide me through the process of creating cost estimates for recurring activities?
    - Follow-up: What tools do you use? How do you ensure your cost estimates are as accurate as possible?
    - Follow-up: How is the calculation library structured in Metacom? Who manages this and how does this information stay valid?
2. From your experience, what are the most common causes for deviations between estimated and actual costs?
    - Follow-up: Could you describe a specific situation where costs were significantly underestimated or overestimated? What happened there?
3. In a cost analysis, staff planning was systematically underestimated. Does this match your personal experience?
    - Follow-up: Could you explain how staff planning estimates were originally determined for the projects you've been involved in?
    - Follow-up: Given this pattern of underestimating staff planning, how would you advise changing future estimation approaches or practices?
4. Which organizational processes, tools, or structures (such as databases, software, meetings, or reviews) do you personally find most useful when preparing accurate cost estimates?
    - Follow-up: Are there specific tools or processes that you think your organization neglects or uses ineffectively?
5. Could you describe how your organization shares knowledge or lessons learned from completed projects? Is it easy for you to share knowledge from one tender to another, within the graduation company or your local branch?
    - Follow-up: Could you give an example of a successful or unsuccessful attempt at cross-project knowledge sharing regarding cost estimates?
6. What are the organization's principles for effective estimation?
    - Follow-up: In your opinion, where in the estimation process are the biggest changes needed?
7. How have past inaccuracies specifically influenced your current approach to tendering?

- Follow-up: Are there adjustments or precautions you now routinely apply due to previous estimation mistakes?

8. I'd like to present you with a statement: 'The organizational culture significantly fosters an environment conducive to knowledge sharing.' Do you recognize this perspective based on your experiences?

Aggregate Dimension 2: Barriers to Cross-Project Learning (SQ3)

9. To what extent are there opportunities to learn from other projects?
    - Follow-up: What internal or external factors make it hard to change current estimation practices?
    - Follow-up: Could you give a recent example where past experiences or historical data influenced this process?
10. What is your opinion about the duration of the estimation process, and does this affect the quality of your cost estimates?
    - Follow-up: What is the interaction between the tender manager and estimation in this context?
11. What does your ideal estimation process look like?
    - Follow-up: What prevents you from realizing this ideal process?
    - Follow-up: What do you think about the difference between initial estimate figures and last-minute discounts or markups?

Aggregate Dimension 3: Strategies for enhancing Cross-Project Learning (SQ4)

12. Where would you start improving knowledge sharing if you were in charge?
    - Follow-up: What would you need to achieve this?
    - Follow-up: Which parties/roles would you need to convince?

NEDERLANDS

Introductievraag: Wat is je rol bij het bedrijf en hoeveel jaar ervaring heb je in deze rol?

Aggregate Dimension 1: Current culture & cross-project Learning practices (SQ2)

1. Kun je vanuit jouw rol mij meenemen in het proces van het maken van kostenramingen voor terugkerende werkzaamheden of items?
   - Vervolg: Van welke tools maak je gebruik? Hoe zorg je dat je kostenraming zo accuraat mogelijk is?
   - Vervolg: Hoe is de bibliotheek in Metacom opgebouwd? Wie is de beheerder en hoe blijft deze actueel?
2. Wat zijn volgens jouw ervaring de meest voorkomende oorzaken van afwijkingen tussen geraamde en werkelijke kosten?
   - Vervolg: Kun je een specifieke situatie beschrijven waarin kosten sterk onderschat of overschat werden? Wat gebeurde er precies?
3. Uit een kostenanalyse van 10 projecten blijkt dat de kosten voor de stafplanning werden onderschat. Komt dit overeen met jouw persoonlijke ervaringen?
   - Vervolg: Kun je toelichten hoe de schattingen voor de stafplanning tot stand kwamen bij de projecten waar jij bij betrokken was?
   - Vervolg: Hoe zou jij adviseren toekomstige ramingspraktijken aan te passen voor de stafplanning?
4. Hoe hebben eerdere ervaringen jouw huidige aanpak van aanbestedingen beïnvloed?
   - Vervolg: Zijn er specifieke aanpassingen of voorzorgsmaatregelen die je nu standaard toepast vanwege eerdere inschattingsfouten?
5. Welke organisatorische processen, hulpmiddelen of structuren (zoals databases, software, bijeenkomsten of reviews) vind jij persoonlijk het meest nuttig bij het maken van accurate kostenschattingen?
   - Vervolg: Zijn er specifieke tools of processen waarvan jij vindt dat jouw organisatie ze verwaarloost of ineffectief gebruikt?
6. Kun je beschrijven hoe jouw organisatie kennis of lessen uit afgeronde projecten deelt? Is het makkelijk om jouw kennis te delen van de ene tender naar de ander? Zowel binnen de vestiging. Als binnen het bedrijf naar andere vestigingen en naar andere bedrijven?
   - Vervolg: Kun je een voorbeeld geven van een geslaagde of juist mislukte poging om kennis over kostenramingen tussen projecten uit te wisselen?
   - Vervolg: Zijn er andere vestigingen die dit beter doen. Zijn er andere organisaties die dit beter doen?
7. Wat zijn binnen de organisatie de uitgangspunten voor een goede calculatie?
   - Vervolg: Wie vind jij verantwoordelijk voor het garanderen dat kennis deling plaatsvindt?
8. Ik leg je graag een stelling voor: ‘De cultuur binnen de organisatie zorgt voor een stimulerende omgeving om kennis te delen.’ Herken je dit beeld vanuit jouw ervaringen?

Aggregate Dimension 2: Barriers to Cross-Project Learning (SQ3)

9. In hoeverre zijn er mogelijkheden om van andere projecten te leren?
   - Vervolg: Welke interne of externe factoren maken het moeilijk om de huidige manier van werken daadwerkelijk te veranderen?
   - Vervolg: Kun je een recent voorbeeld geven waarin eerdere ervaringen of historische data invloed hadden op dit proces?
10. Hoe ziet jouw ideale calculatieproces eruit?

- Vervolg: Wat houdt je tegen om dit ideale proces werkelijkheid te maken?
- Vervolg: Wat vind je van het verschil tussen calculatiecijfer-schrijfcijfer en last minute kortingen of ophogingen?

11. Wat vind je van de doorlooptijd van een calculatieproces en heeft dit invloed op de kwaliteit van je calculatiecijfer?
    - Vervolg: Wat is hierbij de wisselwerking tussen tender manager en calculatie?

Aggregate Dimension 3: Strategies for enhancing Cross-Project Learning (SQ4)

12. Waar zou je beginnen met het verbeteren van kennisdeling als jij het voor het zeggen had?
    - Vervolg: En wat heb je daarvoor nodig?
    - Vervolg: Welke partijen/rollen zou je hierbij moeten overtuigen?

C
Informed consent form

Removed due to privacy concerns.

D

Data Management Plan

Removed due to privacy concerns.